

FRANCE

A Regional and Economic

Geography

by

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PREFACE

PROBABLY no country has so rich a modern geographical literature as France. Since the publication of the great pioneer work of Paul Vidal de la Blache, the *Tableau de la Géographie de la France*, hardly a year has passed without the publication by French geographers of some more or less elaborate study. The output of minor monographs and articles appears to be increasing in geometrical ratio. The geography of France, from the point of view of the trained historian, the geologist, the geomorphologist, has been depicted in works that are universally regarded as classics. From the point of view of the economic geographer, however, a major work has still to make its appearance. While awaiting the publication of such a work from the French geographers, and because no detailed geographical study of France exists in the English language, I have been emboldened to publish the present book, in which I have embodied the results of close study of the subject, covering a number of years.

I have consistently utilized the large-scale maps of the Service Géographique de l'Armée and of the *Carte Géologique de France* of Carez and Vasseur as vital aids and guides in the selection, elucidation and correlation of the masses of literary material, geographical and otherwise, that I have had to consult. I have found the method of working 'on the map' the surest means of keeping a single mind and of avoiding vagueness of outlook and impression. At the same time I have, where possible, checked the visual impressions conveyed by the maps by those received in travelling by road over frequented and unfrequented routes.

There can be few countries where the interrelation of physical and human elements is more striking than in France, and I have been at pains throughout to emphasize the importance of the physical basis of the human geography and of the continuity of geographical influences and controls, though exhibited under varying forms and with changing incidence.

It has been impossible to deal with the historical side of the subject in the scope of a single volume, one has had to be content with noting, in passing, certain geographical features and conditions that have influenced historical events.

The main portion of the book is devoted to the major geographical regions of the country, each of which forms the subject of a special study. The interrelation of the various regions is dealt with mainly in the introductory and economic chapters.

Within each regional study the description and analysis is generally based on the river-basins. This method of description has been adopted partly as a matter of convenience, but is justified because the trunk valleys form as a rule the main rail and water routes, and contain the more important route junctions—the focusing points of commerce and industry—while the branch valleys lead into the heart of the high plains, plateaux and mountain areas, and collect, in the erosion basins of their capillary streams, the life of the agricultural districts. A striking example of the penetration of influence from the centre in the arterial valley to the extremities of the vascular system is dealt with in the consideration of the Lyons economic area, which extends its influence into the valleys of the Jura, Alps, and Central Massif.

I have not, however, allowed myself to be hide-bound by the system I have adopted. It is obvious that to follow too rigidly the method of description by river basins must lead to absurdities. It has therefore been abandoned in the consideration of those regions which do not lend themselves to such treatment; notably in the study of Brittany, where the coastal waters have a far greater unifying significance than the inland waters, and in the discussion of the Middle Rhône, where the Lyons industrial region overlaps into the Upper Loire basin.

The economic section, and particularly the chapter on communications, emphasizes the interdependence of the various regions. In the section dealing with waterways there is deliberate inconsistency of arrangement, in that the Rhine and Rhône are merely referred to, having been considered from the point of view of navigation in the chapters dealing with the regions to which they belong. The Rhine is an international trunk route, in close contact at one point only with France, so that Strasbourg may be regarded as a peripheral port, like Marseilles or Bordeaux, while the Rhône, whose valley forms a vital corridor of national and international importance and whose régime is of great geographical interest, is nevertheless of little significance at present in the French system of navigable waterways. The Seine system, on the other hand, presents no one great arterial stream, but the river with its tributaries and connecting canals forms one of the chief inland navigation systems of western Europe.

This book is intended for those who are accustomed to the use of large-scale maps, and references are given in each chapter to the topographical maps on the scale of 1/200000—the scale that I have found generally to be most satisfactory, as being small enough to enable the reader to grasp at once the features of a reasonably large area, and, at the same time, large enough

to make possible the observation of types of settlement, sites of towns and so on. For the sake of those readers who have not access to such maps, a number of key maps are provided, which give the generalized features of relief and drainage, and the names of most of the places mentioned in the text. In addition there are a number of original maps which have been specially compiled to illustrate and supplement the argument. Here I have to thank Miss D. Wilford, Mr. Montgomerie and Mrs. Whale for the special interest they have taken in the production of the maps.

The Bibliography cannot claim to be complete. It has been necessary to omit a large number of references to short articles and notes which have been read and consulted at various times. Reference has only been possible to those books and articles of which I have made specific use in the text.

I have gratefully to acknowledge the kindness of my colleagues Professor Sargent, Professor Rodwell Jones, Dr. Dudley Stamp, Dr. Wooldridge, Dr. Benham, Mr. Beaver, and Mr. O'Dell, who have read parts of the book in manuscript, and of Mr. Tetley Stephenson who advised me on questions of transport; and I would not forget the help I have received from Mr. Morris, Mr. Lebon and others of my students, past and present, nor the valuable assistance of Miss E. Dell.

I take this opportunity to acknowledge, with affectionate gratitude, a debt of long standing, constantly renewed, to my sister, Miss Dora M. Jones, for her never-failing encouragement and ready help.

My best thanks are also due to Mr. Murray Morrison, Managing Director of the British Aluminium Co., Ltd., to M. Delpont, European Representative of the *Iron Trade Review*, to M. d'Espinasse of the Commission Centrale pour la Navigation du Rhin, to Mr. C. R. Connor of Imperial Chemical Industries, Ltd., and to Mr. Headicar and his colleagues of the British Library of Economics and Political Science, who have taken much trouble to procure material for me and whose help and advice have been invaluable.

I owe a special debt of gratitude to Professor Sargent, who first stimulated my interest in the geography of France. To Sir Halford Mackinder I can never adequately express the debt which, in common with all English geographers, I owe for the inspiration of his teaching. As his assistant for many years I had perhaps fuller opportunities than most of profiting thereby, and I trust I shall not be found altogether to have wasted them.

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CONTENTS

	PAGE
PREFACE	v
PREFACE TO THE SECOND EDITION	viii
PART I—INTRODUCTION	
CHAPTER	
I. GENERAL CONSIDERATIONS	3
Climatic Conditions—Bibliography	
PART II—REGIONAL STUDIES	
II. THE CENTRAL MASSIF	27
The Loire and the Eastern Massif—The Allier and the Auvergne Highlands and Basins—The Cher, the Creuse, and the Plateaux of Combrailles and Marche—The Vienne and the Limousin Plateaux—Bibliography	
III. THE ARMORICAN MASSIF	75
Brittany—The Continental Base of the Massif—Bibliography	
IV. THE PARIS BASIN	103
The Seine Basin above Paris—The Oise Basin—Paris—Upper Normandy—The Middle Loire—The Lower Loire—Bibliography	
V. NORTH-EASTERN FRANCE	166
Picardy, Artois, and Flanders—Bibliography	
VI. THE PYRENEES	200
The Eastern Pyrenees—The Central Pyrenees—The Western Pyrenees—Bibliography	
VII. THE BASIN OF AQUITAINE	229
Bibliography	
VIII. THE FRENCH ALPS	244
Bibliography	
IX. THE RHÔNE-SAÔNE CORRIDOR	261
The Saône Basin—The Jura—The Rhône Basin—Bibliography	
X. THE MEDITERRANEAN REGION	297
Provence—The Plains of the Rhône Delta, Crau and Camargue—Bas Languedoc—Eastern Provence—Marseilles—Corsica—Bibliography	

CHAPTER	PAGE
XI. EASTERN FRANCE	323
Lorraine—The Lorraine Iron-fields—The Sarre Basin— The Meuse Basin—Alsace—The Rhine and Strasbourg— Bibliography	
PART III—ECONOMIC GEOGRAPHY	
XII. AGRICULTURE	393
General Considerations—Forests and Orchards—Pasture and Livestock—Chief Crops—Market Gardening and the cultivation of <i>Primeurs</i> —Vineyards	
XIII. INDUSTRY	425
Coal — Electricity — Iron and Steel — Aluminium — Chemicals—Textiles	
XIV. COMMUNICATIONS	457
Waterways—Railways	
BIBLIOGRAPHY	497
APPENDIX I—STATISTICS	502
APPENDIX II—ECONOMIC CONDITIONS, 1939-47	511
INDEX	518

LIST OF ILLUSTRATIONS

FIG.		PAGE
1.	Generalized Relief Map of France	5
2.	Diagram showing Dominant Areas of High and Low Pressure	9
3.	Average Annual Rainfall of France (<i>after Angot</i>)	10
4.	Rainfall for October	11
5.	Rainfall for January	12
6.	Rainfall for April	14
7.	Rainfall for July	16
8.	Graphs indicating Pluviometrical Fractions	17
9.	Division of France into Climatic Regions	18
10.	Typical Rainfall Graphs	20
11.	Typical Temperature Graphs	22
12.	Simplified Geological Map of the Central Massif	28
13.	The Central Massif showing Relief	32
14.	The Forez Basin	40
15.	Map showing the Relation of the Forez and Jarez Districts to the Rhône Valley and Lyons	41
16.	The Roannais	43
17.	A Typical Catchment Basin in the High Moors	46
18.	Map showing Contrast between the Hydrography of the Causses and that of the Impermeable Rocks north of the Lot	66
19.	Generalized Geological Map of the Armorican Massif	76
20.	The Armorican Massif, showing Relief and Drainage	79
21.	The Paris Basin. Key to Fig. 22	104
22.	The Hydrographical Features of the Paris Basin	105
23.	The Plateau of Langres	109
24.	Alise Ste. Reine	111
25.	Châlons-sur-Marne	123
26.	A Tabular Summary of the More Important Tertiary Rock Formations Exposed in the Paris Basin	125
27.	Map to show the Position of Reims and Epernay	127

FIG.		PAGE
28.	Paris	136
29.	Industrial Paris	143
30.	The Port and Industrial Area of Rouen	146
31.	The Plain of Caen, showing Iron Concessions	151
32.	The Middle and Lower Loire Basins	156
33.	Nantes and St. Nazaire	163
34.	North-Eastern France showing Relief and Drainage	167
35.	Amiens	169
36.	The Weald of Boulonnais	172
37.	The Flanders Plain and the Sill of Artois	179
38.	The Belgian Waterways and their Transfrontier Communications	184
39.	The Canals that serve the Western Coal-field	194
40.	The Industrial Region of Nord and Pas-de-Calais	197
41.	The Pyrenees, showing the Broad Lithological Distributions	202
42.	The Eastern Pyrenees and the Plain of Roussillon	208
43.	The Basin of Andorra	210
44.	The Limestone Zone of the Central Pyrenees and the Detritic Hill Country to the North	213
45.	The Gave de Pau, showing position of Morainic Deposits	217
46.	The Western Pyrenees	220
47.	The Basin of Aquitaine	230
48.	The Gate of Carcassonne and the Col de Naurouze	233
49.	Generalized Plan of the French Alps	247
50.	The French Alps and the Basin of the Middle Rhône	248
51.	The Saône Basin	265
52.	The Gate of Burgundy, or Belfort Gap	266
53.	Besançon	275
54.	The City of Lyons	286
55.	Map of the St. Etienne Industrial District '	291
56.	Provence and Bas Languedoc	298
57.	Marseilles	309
58.	The Massif of Corsica	320

LIST OF ILLUSTRATIONS

xiii

FIG.	PAGE
59. Relief Map of Alsace and Lorraine	324
60. Alsace and Lorraine. A Generalized Geological Map	327
61. The Lorraine Basins of the Meuse and Moselle	334
62. The Nancy Iron-Mining and Metallurgical Region	344
63. The Metz-Thionville, Briey and Longwy Iron-Mining and Metallurgical Areas	348
64. The Monts Faucilles and the Meuse-Saône Divide	360
65. Distribution of Population in Alsace	373
66. The Upland and Lowland Forests of Lower Alsace	375
67. The Saverne Gap	377
68. The Port of Strasbourg	385
69. Departmental Map of France	392
70. Distribution of Sheep by Departments, 1937	400
71. Distribution of Cattle by Departments, 1937	404
72. Distribution of Milch Cows by Departments, 1937	407
73. Wheat Production by Departments, 1937	409
74. Production of Oats and Olives, 1937	412
75. Production of Barley and Rye, 1937	413
76. Production of Buckwheat and Sugar-Beet, 1937	414
77. Production of Wine by Departments, 1937	418
78. Value of Wine produced by Departments, 1937	419
79. Champagne Wine Industry	422
80. Annual Production of Wine in France	423
81. Production of Thermal- and Hydro-Electric Power in 1936 by Departments	426
82. Production of Steam-Power used for Machinery in 1936 by Departments	428
83. Graph showing Annual Coal Consumption, 1928-38	432
84. Graph showing Coal Production, 1928-38	432
85. Graph showing Sarre Coal Production, 1928-34	432
86. The Sarre and Lorraine Coal Deposits	434
87. Electrical Energy Consumed in Chemical and Electro-Metallurgical Work, 1936, by Departments	439
88. Graph showing Iron-Ore Production, 1928-38	442
89. Graph showing Pig Iron Production, 1928-38	442

FIG.		PAGE
90.	Graph showing Steel Production, 1928-38 . . .	442
91.	The Metallurgical District of the Centre . . .	445
92.	Electrical Energy Consumed in Transport, 1936, by Departments	458
93.	The Areas Served by the French Railway Companies	459
94.	The North-Eastern System of Waterways . . .	471
95.	The Canals Serving the Channel Ports . . .	473
96.	Coal Traffic on the Northern Waterways . . .	475
97.	Waterways Connecting the Paris Basin with the Northern Coal-field	477
98.	Coal Traffic on the Paris Waterways . . .	482
99.	The Waterways of Alsace-Lorraine and Burgundy, and their connections with the Paris Basin .	487
100.	The Navigable Waterways of the Lower Loire and Brittany	492
101.	The Saône-Rhône Waterway and the Canals of Provence and Languedoc	493
102.	The Navigable Waterways of the South-West . .	495
103.	Density of Population by Arrondissements . .	503

PART I
INTRODUCTION

FRANCE

PART I

INTRODUCTION

CHAPTER I

GENERAL CONSIDERATIONS

A COUNTRY is a reserve of energies whose origin lies in Nature, but whose development depends upon Man. It is Man who, by moulding the land to his own purposes, brings out its individuality. He establishes a connexion between its separate features. He substitutes, for the incoherent effects of local circumstances, a systematic concourse of forces. It is thus that a country defines and differentiates itself and finally becomes, as it were, a medal struck in the effigy of a people.¹ Thus Vidal de la Blache expresses the idea of the intimate interaction of natural forces and human activities that go to make up a nation. France, it has been said, is more one country and one nation than any other country and nation in the world; and few will deny that, to the outside world at least, France speaks with one voice. More perhaps than most lands, she has developed the sense of nationality, of unity.

Yet, in no part of Europe has Nature brought together such contrasts of land form, soil, and climate as she has within the frontiers of France. Upon France almost all the great structure lines of Europe converge—ruins of the great mountains of Carboniferous times, magnificent, lofty curves of the Tertiary up-folding, great basins filled with the sediments of agelong erosion, alluvial flats but recently reclaimed from the sea—all these are represented in France. No other nation of the continent has such diversity of outlook, for, being the western terminus of the great European peninsula, of which the British Isles and Spain are but projecting horns, she looks out north, north-west, west and south upon four seas. This diversity of structure and relief is reflected in a rich variety of climate, wherein France again exemplifies, though not in their extreme form, the contrasting

¹ P. Vidal de la Blache : *Tableau de la Géographie de la France*, p. 8.

types of the continent as a whole. Moreover, elements of isolation are not wanting in the broad stretches of sparsely populated upland, which separate the great sedimentary basins and themselves include innumerable intermontane depressions.

Yet it would hardly be true to say that France summarizes the general geographical characteristics of Europe. The broad, low, windswept limestone plateaux of northern France have nothing in common with the great glaciated plains of northern Europe, with their zones of marshy, forested lowland, alternating with sandy ridges of glacial detritus. The low western Armorican Massif, representing the Block Mountain system, has no close counterpart in central or continental Europe, and bears but a faint resemblance to its twin peninsula across the Channel. Although the Central Massif and the Vosges reproduce, in many respects, the characteristic features of the Rhine plateau and the Bohemian block, yet, owing to their numerous penetrating river valleys, they do not form to the same extent barriers to circulation and settlement. Even the French Alps, owing largely to the effect of aspect on climatic conditions, differ markedly from the Alps of the centre and east.

By her very variety of landscape, then, France has marked individuality, and the great feature lines that she shares with other European countries are so modified within her frontiers as to distinguish her from, rather than to unite her to, her more essentially continental neighbours, while her compact shape does not accord with the peninsularity of Europe as a whole.

For her political and social unity in this physical diversity France has to thank, also, her very definite geographical frontiers—the long sea front and the mountain walls. Only three-seventeenths of her frontier can be described as non-geographical. The North Sea, the Channel, the Bay of Biscay, the Pyrenees, the Mediterranean, the Alps—these are boundaries about which there can be no serious dispute. The north-eastern land front, it is true, except where the Rhine Slate plateau forms a natural barrier, has not the same clear definition. The boundary that gives to France a section of the Brussels Basin is purely arbitrary, and behind it the long, low ridge that prolongs the Wealden upfold of south-eastern England dips gently in the Sill of Artois, giving an easy line of communication between Paris and Brussels, by which more than once in the geological history of the region the sea penetrated from the north, and which has afforded a passage-way in peace and war from time immemorial. The political boundary here has been shifted backwards and forwards in the course of history, and it is only by international treaty in modern times that it has attained to something of

permanence and stability. In the Ardennes and low Vosges the frontier line appears again to be, except in detail, of an arbitrary nature. Nor has the frontier which stretches across the Ardennes and the Lorraine plateau any marked geographical basis. From the neighbourhood of Hirson on the upper Oise it follows roughly the edge of the Rhine Slate plateau as far as the basin of the

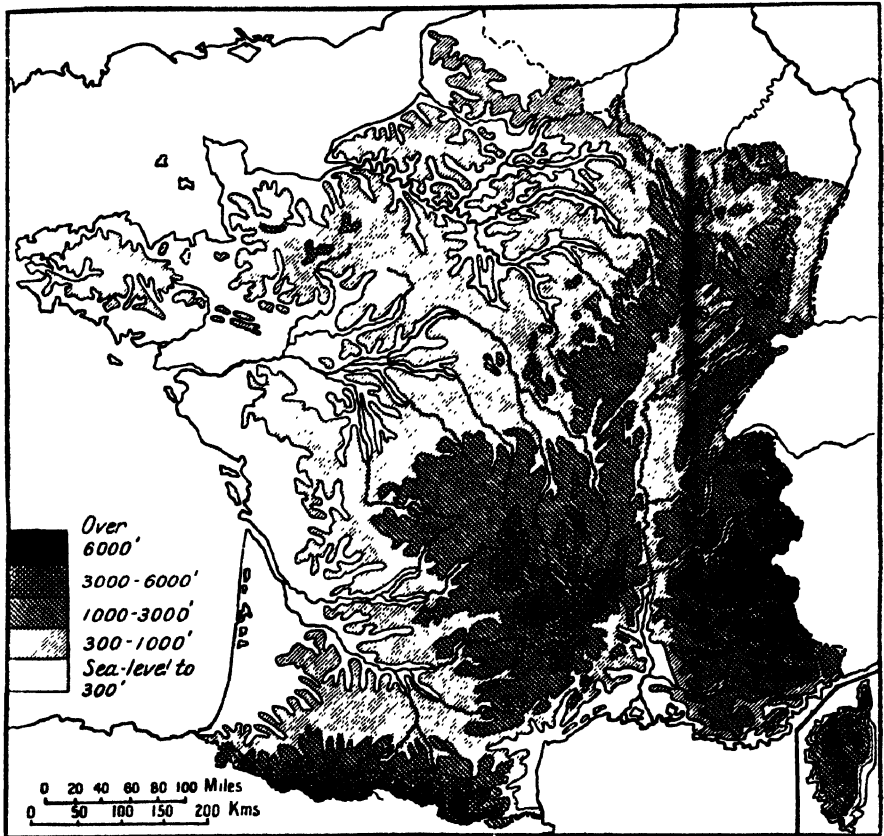


FIG. I. GENERALIZED RELIEF MAP OF FRANCE

Sarre ; but the line it then takes across the plateau of Lorraine and across the Sarre coal basin to the river Lauter is purely arbitrary. The Lauter, which forms the northern political boundary of Alsace, is an insignificant feature, but north of the stream a belt of forest in the Rhine plain forms something of a natural barrier.

The boundaries of France are thus closed to those countries where natural affinities of race, language and civilization might

engender centrifugal tendencies and lie open only to regions alien in language and culture.

France owes her unity, in the second place, to the centralizing effect of her river systems. Thirty-eight per cent of the land surface drains to the Seine or to the Loire, whose lower basins, between which there is no barrier of elevation, comprise 53 per cent of the lowland, that is, of the land below 600 feet above sea-level. In other words, the largest stretch of open, fertile, low-lying land in France—the plains of the Loire and Seine—lies not on the rim of the land, but towards the centre. Moreover this land is trenched by converging watercourses, most of which are navigable in an economic sense; and the valleys of these watercourses themselves provide natural routes with easy gradients; the valley slopes offer possibilities of intensive cultivation which is reflected in lines of denser settlement, linking the centre with the outlying areas. Then, again, so compact is the country, that no part of the 210,000¹ square miles of the mainland of France is more than 380 miles from Paris. True, the barrier presented by the Central Massif to human and climatic conditions, though far from complete, does justify geographically the recognized division of France into *nord* and *midi*, and it would be idle to suggest that this conception is not reflected in past history and present politics. Yet man, in the course of history, has so emphasized the natural nodality of the centre of the Paris basin that Paris has become, in modern times, not only the focusing point of the northern plains but the dominating factor in the unification of France as a whole; and although physical diversity, dividing the countryside into separate *pays*, in which a sense of local patriotism is definitely related by the inhabitants to geographical distinctions, provides an antidote to undue centralization, yet a Frenchman is always a Frenchman first and a Gascon or an Auvergnat second.²

A third factor tending to the unity of the country is to be found in the extraordinary extension of the limestone outcrops which cover almost the whole of the Paris basin and completely encircle the Central Massif, rendering circulation of men and ideas and goods comparatively easy in both ancient and modern times.³

¹ As estimated by the Service Géographique de l'Armée.

² It is interesting to note that an Alsatian will speak of 'un français de France' as distinguished from an Alsatian Frenchman.

³ In enumerating thus the physical factors that have made for the unifying of France, we do not, of course, claim that these were the only geographical factors concerned, but merely that, in an appreciation of France as an entity, these influences must be reckoned with. It must not be forgotten, for instance, what France owes to her magnificent system of roads which, despite the need of superficial adaptation to modern transport conditions, are a monument to the

A fourth element, that is only partly geographical, is the extraordinarily unbroken distribution of population, such that real isolation is very rare, and that right across such seeming obstacles as the Vosges and the Cévennes spreads a continuous, though attenuated, sheet of settlement. No area is really isolated, and the very variety of structure and climate has, in rendering France to a large extent self-sufficing, made necessary much intercommunication within her borders.

We must study France, then, in her physical variety to understand how she has been able to use her natural advantages to build up economic and political unity.

Nature has divided the land of France into major regions, differing essentially each from its neighbours in land form, river system, climate, and soil. The Alps, the Pyrenees, and the Ardennes are peripheral features, hemming in the country, while linking France structurally and morphologically with other lands. The crustal block of the Central Massif, projecting north-eastward in the Morvan, and sinking beneath the Langres plateau to reappear as the Vosges, stretching north-westward into the Armorican Massif, and southwards in the Rouergue and the Montagne Noire, forms the essential framework or skeleton of the country. Between these extending arms of the massif and the peripheral uplands or the sea lie the great depressions, filled with sedimentary rocks: the Paris basin, the basin of Aquitaine, and the series of foundered basins that constitute the Rhône-Saône corridor. Two of the most important lowlands of France, however, the *Nord* region and Alsace, lie outside this natural framework, although linked to the interior of France by natural lines of communication as well as by historic and economic ties.

In the following series of studies we have tried to describe the various natural regions in such a way as not only to present a clear picture of the stage and scene of human activities, but also to show something of the complicated interaction of the various geographical factors concerned, both among themselves and with the human elements whose existence is so closely bound up with them.

CLIMATIC CONDITIONS

Just as France contains representatives of the main structural features of Europe, ~~Spain~~ she also exhibits the three main European climatic types—maritime, Mediterranean, and continental. The

foresight of her administrators and to the skill of her engineers. They leave scarcely a corner of the country, however remote, really inaccessible, and the motor-car has multiplied a hundredfold their centralizing and unifying influence.

three factors that are most important in determining the climatic types in France are latitude, position in relation to the continent of Europe and the Atlantic, and the broad lines of relief.

With regard to the first factor, the situation between 42 degrees and 51 degrees north means that the northern part of France lies always in the track of the variable westerly winds of the Northern Hemisphere, which, having crossed the north Atlantic, with its warm surface drift, are warmed and have a high water-vapour content ; and are characterized, moreover, by the large number of cyclonic depressions that accompany them. The southern part of France comes within the track of the westerlies in the winter half year only. For the rest of the year winds tend to be north-easterly, flowing from the continent towards the Mediterranean.

The position of France at the western extremity of the mainland of Europe, where it tapers towards the Atlantic, means that marine influences are experienced in the west and continental influences have effect in the east. As the mountain systems of Europe are aligned from east to west, there is no great barrier to Atlantic climatic influences, which are thus able to penetrate far into the interior, with the result that, although continental conditions are experienced in eastern France, they present themselves only in a modified form.

The relief of the land, the third factor, plays an important part in limiting the areas over which the various climatic types prevail. The Central Massif, for example, with its steep edge overlooking Provence and Bas Languedoc, confines the area of Mediterranean climate to the coastlands.

In order to be able to grasp the climatic régime of France it is necessary to know something of the pressure systems dominant at the various seasons of the year, for they, of course, determine the direction and velocity of the prevailing winds, and, what is more important, they determine the track of the cyclones that approach the coasts of western Europe and account for most of the rain that falls in the winter half of the year.

The pressure conditions that determine the climatic régime of France are those common to all western Eurasia. They vary in the importance of the rôle they play according to the seasons. In winter the Azores 'High', the Continental 'High', and the western Mediterranean 'Low' indicate dominant conditions.¹ In summer the Azores 'High' and the Arabian 'Low' seem to be dominant, with the additional factor of the more or less permanent 'High' of the Balkan Peninsula. Fig. 2 shows in a very

¹ The Greenland 'High' and the Icelandic 'Low' have a less direct influence in France.

generalized way the functions of these factors of pressure distribution in the summer and winter months. In winter the Azores 'High' lies normally west of Morocco and extends a tongue across North Africa. At the same time a great mass of cold, inert air lies over continental Asia, having its centre over the Lake Baikal district and extending in a long tongue over Europe as far as the Rhine. This mass emits processes which extend sometimes over Scandinavia, sometimes in a south-westerly direction, when a bridge of high pressure may be formed across the

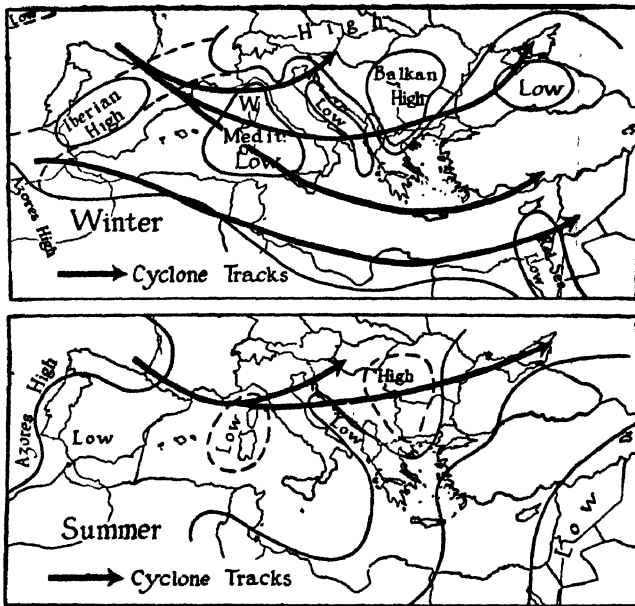


FIG. 2. DIAGRAM SHOWING IN A GENERALIZED WAY THE DOMINANT AREAS OF HIGH AND LOW PRESSURE, IN WINTER AND SUMMER, THAT INFLUENCE CLIMATIC CONDITIONS IN SOUTHERN FRANCE

Iberian peninsula connecting with the Azores 'High'. When this occurs, the cyclones which pass in procession across the Atlantic from the coasts of North America, unable to penetrate into the Mediterranean, sheer off north-eastward across the British Isles and Scandinavia or North Germany along the northern edge of the continental high-pressure mass. Northern France is then affected by their southern quadrants only, and gets alternating spells of cold, bright, sunny weather and periods of relatively warm, cloudy weather accompanied by gales of wind and rain.

If the Azores ' High ' and the Continental ' High ' are separated by a saddle of low pressure, cyclonic depressions find easy passage to the western Mediterranean, where, between the Continental and North African areas of high pressure, the pressure is always relatively low, owing to the retention of heat acquired in summer in the mountain-ringed basin. Passage of cyclones into the

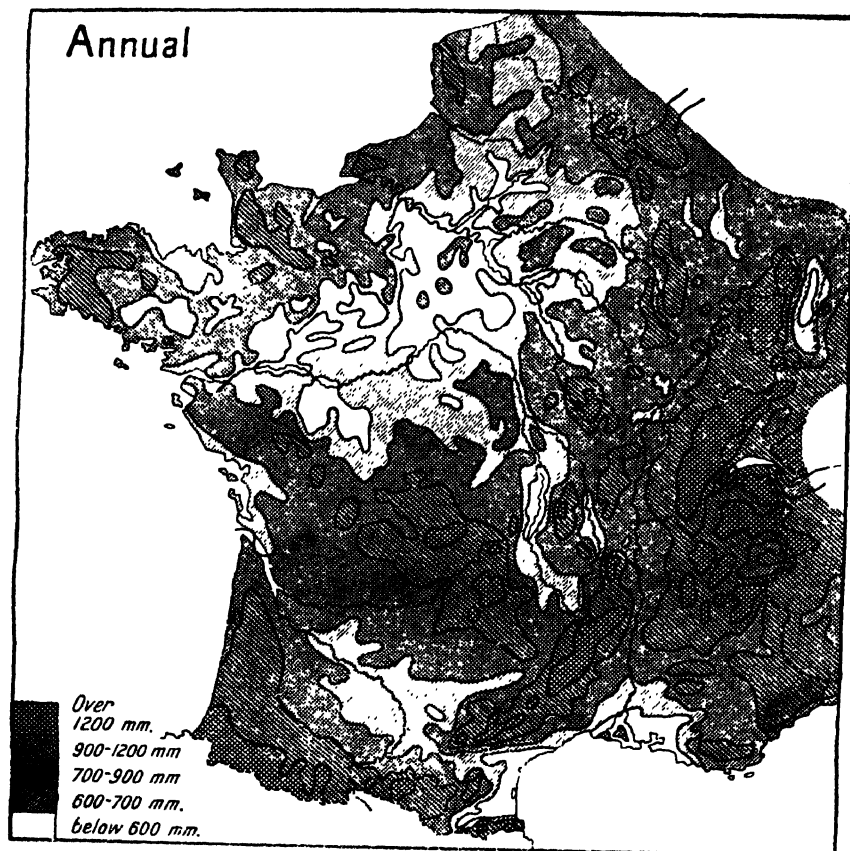


FIG. 3. SHOWING AVERAGE ANNUAL RAINFALL OF FRANCE (AFTER ANGOT)

Mediterranean takes place generally over the gap between the Central Massif and the Pyrenees, but sometimes between the Sierra Nevada and the plateau of Morocco. Occasionally deep cyclones originate in the western Mediterranean itself. The track of cyclones through the Mediterranean depends upon the season. During spring and autumn they frequently pass from the Mediterranean northwards over the Po plain ; at other times

they turn north over the Balkan peninsula ; sometimes they sweep north-west and pass over the Black Sea. In the winter months their course is farther south, and they affect the north coast of Africa and traverse the eastern Mediterranean. But whichever course they take ; they cross the western Mediter-



FIG. 4. RAINFALL FOR OCTOBER (AFTER ANGOT). HEAVY RAIN IS TYPICAL OF THE MARITIME AND NORTHERN MEDITERRANEAN DISTRICTS. NOTE ALSO THE HEAVY RAINFALL OF THE EASTERN AND CENTRAL HIGHLANDS.

anean basin, where, according to their position, they either cause on-shore winds with heavy precipitation, or draw cold winds down from the Cévennes and the Alps. It is in autumn, when the sea is at its warmest and the winds are therefore carrying large amounts of water vapour, and cyclonic disturbances are most frequent, that the heaviest rains fall. In March, when the

If the Azores ' High ' and the Continental ' High ' are separated by a saddle of low pressure, cyclonic depressions find easy passage to the western Mediterranean, where, between the Continental and North African areas of high pressure, the pressure is always relatively low, owing to the retention of heat acquired in summer in the mountain-ringed basin. Passage of cyclones into the

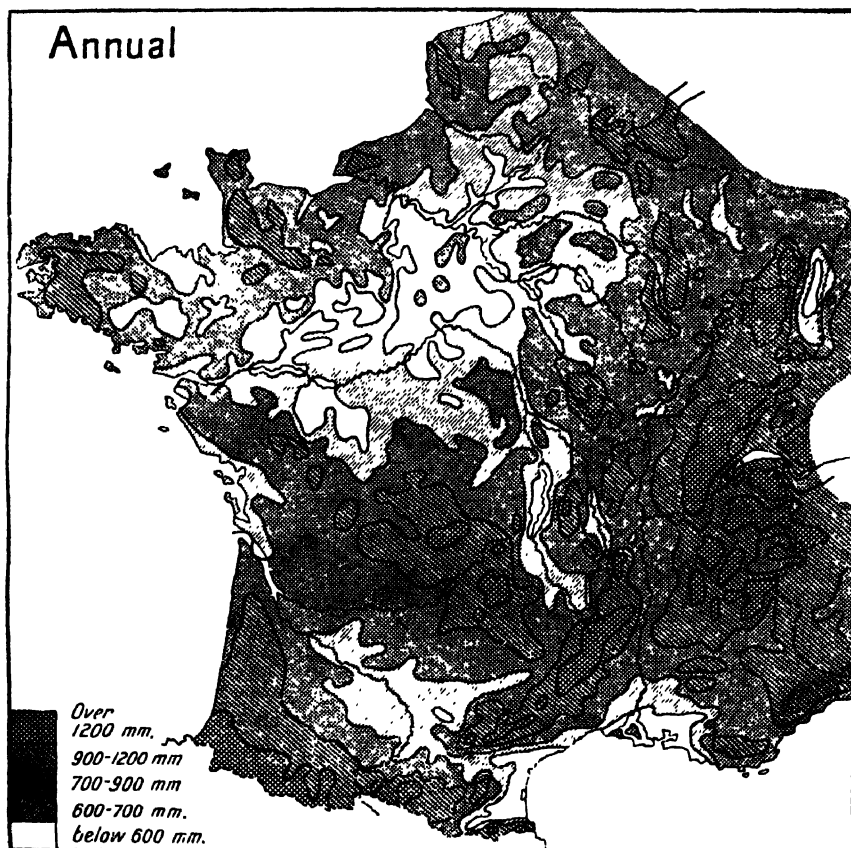


FIG. 3. SHOWING AVERAGE ANNUAL RAINFALL OF FRANCE (AFTER ANGOT)

Mediterranean takes place generally over the gap between the Central Massif and the Pyrenees, but sometimes between the Sierra Nevada and the plateau of Morocco. Occasionally deep cyclones originate in the western Mediterranean itself. The track of cyclones through the Mediterranean depends upon the season. During spring and autumn they frequently pass from the Mediterranean northwards over the Po plain ; at other times

they turn north over the Balkan peninsula ; sometimes they sweep north-west and pass over the Black Sea. In the winter months their course is farther south, and they affect the north coast of Africa and traverse the eastern Mediterranean. But whichever course they take ; they cross the western Mediter-

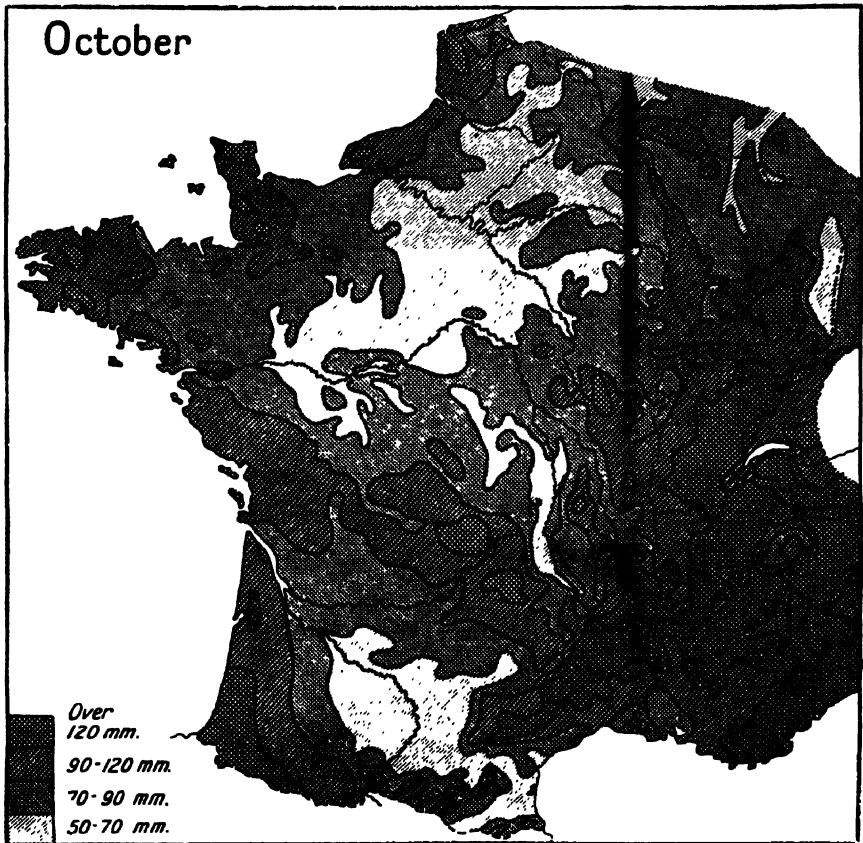


FIG. 4. RAINFALL FOR OCTOBER (AFTER ANGOT). HEAVY RAIN IS TYPICAL OF THE MARITIME AND NORTHERN MEDITERRANEAN DISTRICTS. NOTE ALSO THE HEAVY RAINFALL OF THE EASTERN AND CENTRAL HIGHLANDS.

anean basin, where, according to their position, they either cause on-shore winds with heavy precipitation, or draw cold winds down from the Cévennes and the Alps. It is in autumn, when the sea is at its warmest and the winds are therefore carrying large amounts of water vapour, and cyclonic disturbances are most frequent, that the heaviest rains fall. In March, when the

pressure belts begin to swing north again, there is a slight recurrence of cyclonic rains, but the zone of westerly winds soon swings beyond the Mediterranean region.

During the summer months the pressure belts move northwards. The Azores 'High' extends northwards and the relative

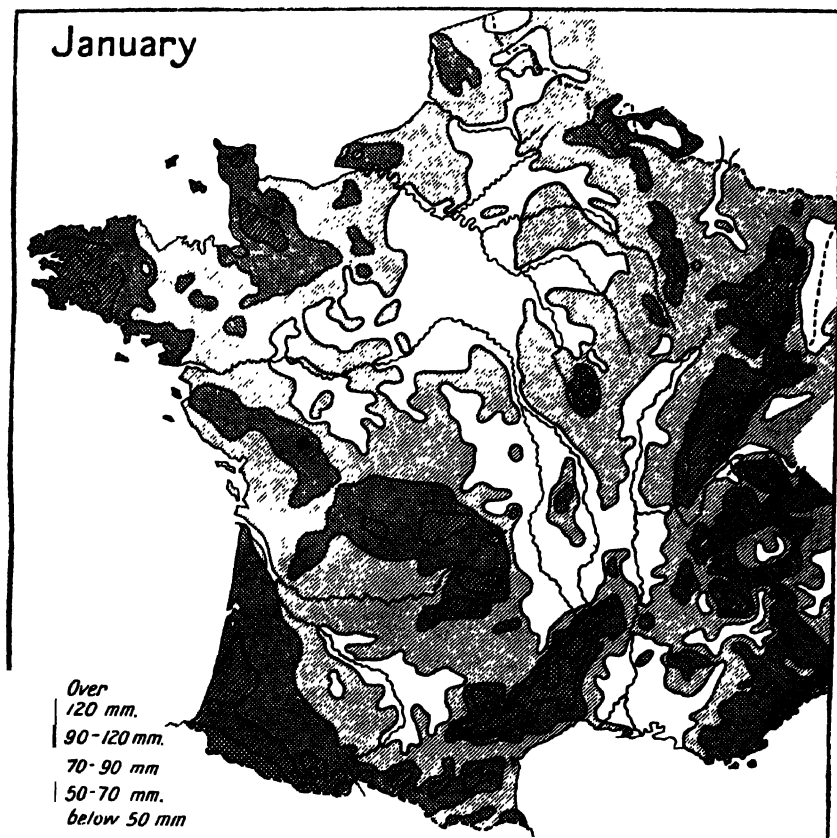


FIG. 5. RAINFALL FOR JANUARY (AFTER ANGOT). MARK THE RELATIVE DRYNESS OF THE INTERIOR LOWLANDS DUE TO DISTANCE FROM THE SEA OR TO 'RAIN SHADOWS'.

coolness of the sea in affecting the coastlands causes it to spread for some distance into the interior, often covering the Iberian peninsula and south-western France. The Arabian 'Low' extends its influence northwards, sometimes coalescing with the low pressure system which, in summer, replaces the Continental 'High'. There is now no obstacle to the passage eastwards over

the Continent of Atlantic cyclones. These, however, are now much less frequent and more feeble in character than in the winter half year, and soon dissipate altogether when they reach the interior. The heavy rains that occur in the summer in eastern and central France are due for the most part to local thunder-showers, which are sometimes intensely heavy. In the south, during summer, the isobars run as a rule almost north and south between the Atlantic 'High' and the Arabian 'Low', and winds, as a result, tend to be northerly and therefore dry. The pressure gradient is too shallow for there to be a general movement of air from west to east, and there is often a barrier of relatively high pressure extending from the Balkan plateau south-westwards across the Mediterranean.

Relief is, of course, an important factor affecting both temperature and rainfall over large areas in France, as is shown very clearly on the annual rainfall map, Fig. 3, where the uplands stand out in sharp contrast. Altitude has a direct effect also on the régime of the rainfall, as M. Angot has repeatedly pointed out,¹ tending to exaggerate the amount falling in the autumn, when the sea-winds contain their maximum amount of water vapour, and to lessen the amount of summer convectional rains, thereby minimizing the effect of distance from the sea. Marked rain-shadows occur in the restricted intermontane plains, where the winds descend abruptly from great heights, as in the Limagne and the plain of Alsace.

The accompanying maps bring out very clearly a number of interesting facts. Fig. 3, showing the annual rainfall, indicates very plainly the regions of maximum rainfall due (a) to exposure to maritime influences, and (b) to elevation. It is interesting to note that proximity to the coast by itself is not sufficient to ensure heavy rainfall. It is only those sections of the Atlantic coast that rise abruptly, if only to moderate heights, from the sea that have a rainfall above the average, e.g. the plateau of Caux. The apparent exception of the Landes would seem to be due to the great height of the Pyrenean barrier near the coast. Apart from the coastal areas the map of annual rainfall distribution would make a fairly accurate relief map. All the major river valleys show up as areas of low rainfall; the steep-edged depressions of the upper Loire and Allier lying in rain-shadows, being particularly noticeable. The Paris basin area of low rainfall might appear at first sight to be due to the gradual descent towards the centre of the basin. The relief conditions, however, hardly justify this assumption. The decrease

¹ A. Angot: 'Régime pluviométrique de la France' (*A. de G.* 1917, 1919, 1920, and 1921).

in rainfall corresponds to increasing distance from the coast, in other words, to the transition to continental conditions ; it ceases to be progressive on the eastern side owing to the counteracting influence of the elevation of the rim of the basin.

Apart from the river basins the only areas of markedly low rainfall are the Mediterranean basins of the eastern Pyrenees and

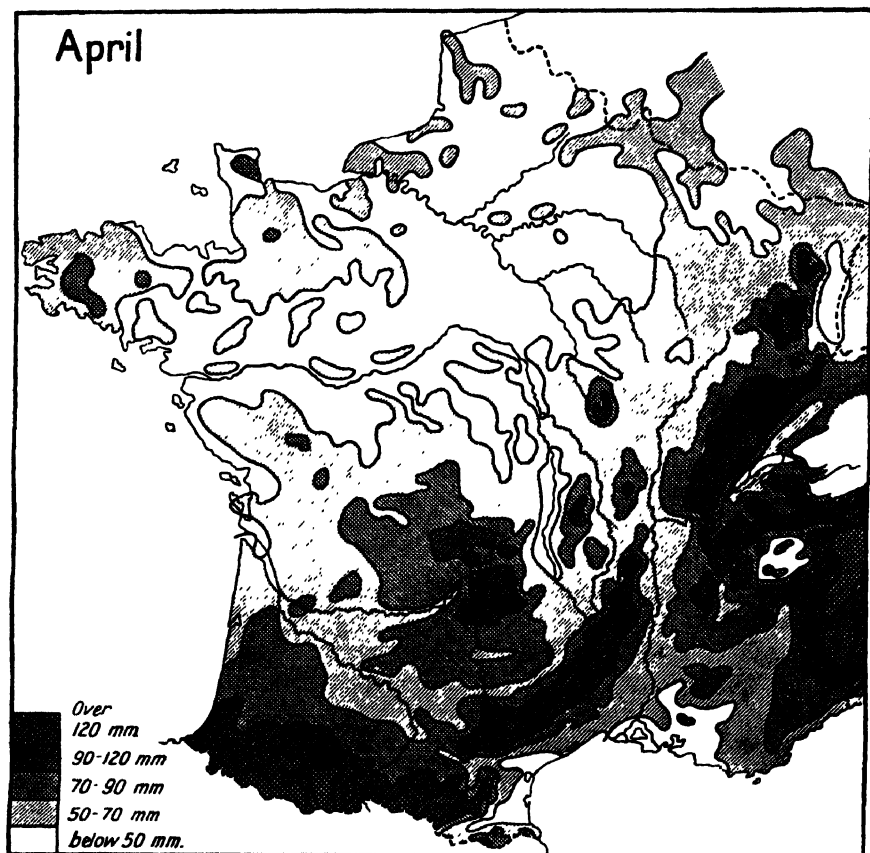


FIG. 6. RAINFALL FOR APRIL (AFTER ANGOT). THE SPRING MINIMUM IS MARKED IN THE NORTH

the Rhône delta, the first lying in the rain-shadow of the Pyrenees and the Montagne Noire and the second being the Mediterranean lowland farthest removed from the Cévennes and the Alps.

The October map shows the heaviest rainfall of the year. The whole of France is in the track of the westerlies at this season. It is the period when the winds from the Atlantic are most warm

and vapour-laden, while the land is cooling rapidly. The coast-lands are receiving their maximum rainfall; altitude, owing to the warmth of the sea winds and their water-vapour holding capacity, has its maximum effect in inducing precipitation. Moreover, cyclonic disturbances at the turn of the year are frequent and violent. No part of France has less than 20 inches of rain.

The map for January shows a falling off of rainfall in northern France due to the spread of anticyclonic conditions and the diminished capacity of sea winds for carrying water-vapour. The relative distribution of rain over France remains much the same as in October.

In April the effect of the diminution in the number and violence of the cyclonic disturbances is noticeable. Rainfall decreases everywhere in northern France, and particularly in the maritime regions. In south-central France, on the other hand, away from the Atlantic and Mediterranean coasts, continental conditions begin to express themselves in an increased rainfall.

In July, for the first time the *Midi* is sharply divided from the rest of France. The rainfall is negligible here at this season, for it now lies outside the influence of the zone of the westerlies. Marine influences have ceased to exert an important control on the Atlantic coast from Morbihan southwards. On the other hand, the tendency to a summer maximum has full play in central and eastern France. This is particularly noticeable in the Central Massif. In the Paris basin the area of rainfall minimum has disappeared, marking once more the tendency to continental conditions.

In Figs. 8 and 9 an attempt has been made to divide France into climatic regions on a basis of the rainfall régime as determined by M. Angot.¹ The rainfall graphs are selected as being typical of each division. They show, for selected departments, the average proportional pluviosity in fractions of 1,000 for each month. Graphs for six typical stations are given in Fig. 10 to indicate the average actual rainfall for each month. A comparison of the two will bring out the fact that the month of February is a relatively dry month as a rule, quite apart from its shortness of duration.

CLIMATIC DIVISIONS. The first of these, No. 1A is the area of *typical maritime climate*. It has a moderate, well-distributed rainfall, the larger part of which falls in the winter half year. The highest monthly fall occurs in autumn. The temperature is moderate with an average of about 40° F. in winter and 65° F. in summer. The temperature range, both annual and diurnal,

¹ Angot, *op. cit.*

owing to the moderating influence of the sea, is slight ; hence summer thunder-showers are rare, as also are frost and snow. There is much moisture in the air owing to the frequent passage of cyclones. The spring is long and early, the autumn short. The limits of the area are determined by the rainfall régime.

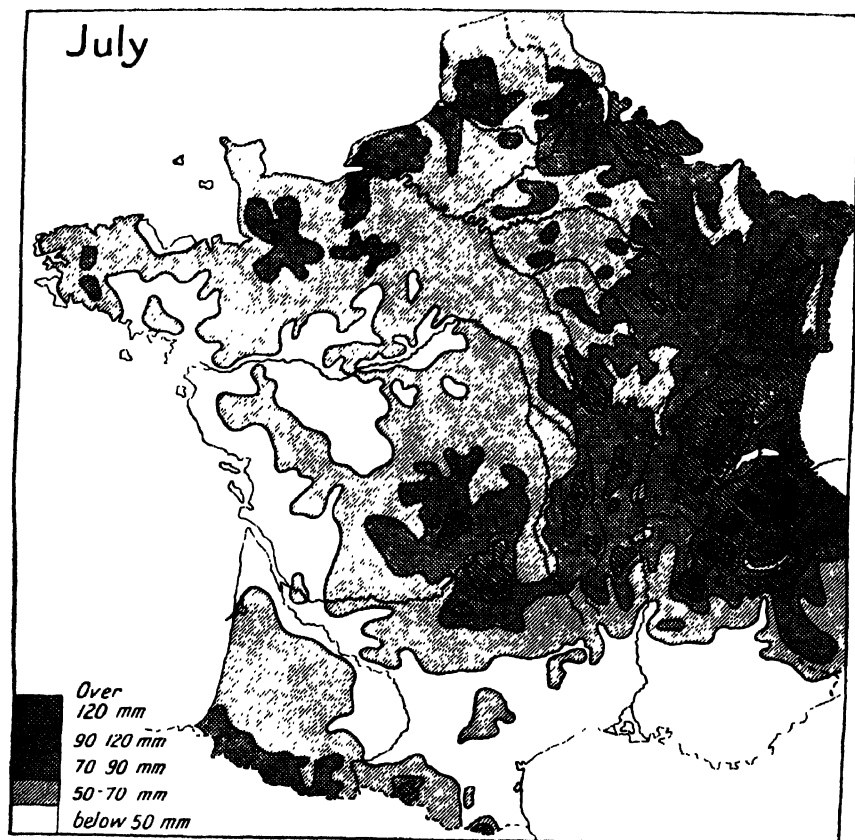


FIG. 7. RAINFALL FOR JULY (AFTER ANGOT). NOTE THE SUMMER RAINFALL OF THE PARIS BASIN AND THE DROUGHT IN THE MEDITERRANEAN LANDS, INCLUDING THE SOUTHERN ALPS.

The conditions described above are confined to the coastal areas, and the typical rainfall distribution occurs only in the west of Brittany in the departments of Finisterre, Morbihan and Côtes du Nord, in the Channel Isles and in the department of Manche (Cotentin peninsula).¹ In Basse Normandie, to the south, there

¹ See p. 13.

is a gradual modification of the amount and distribution of the rainfall.

The relatively high rainfall shown on the typical graph as occurring in the winter half year is due to the fact that the cyclonic depressions are more frequent and deeper in that period

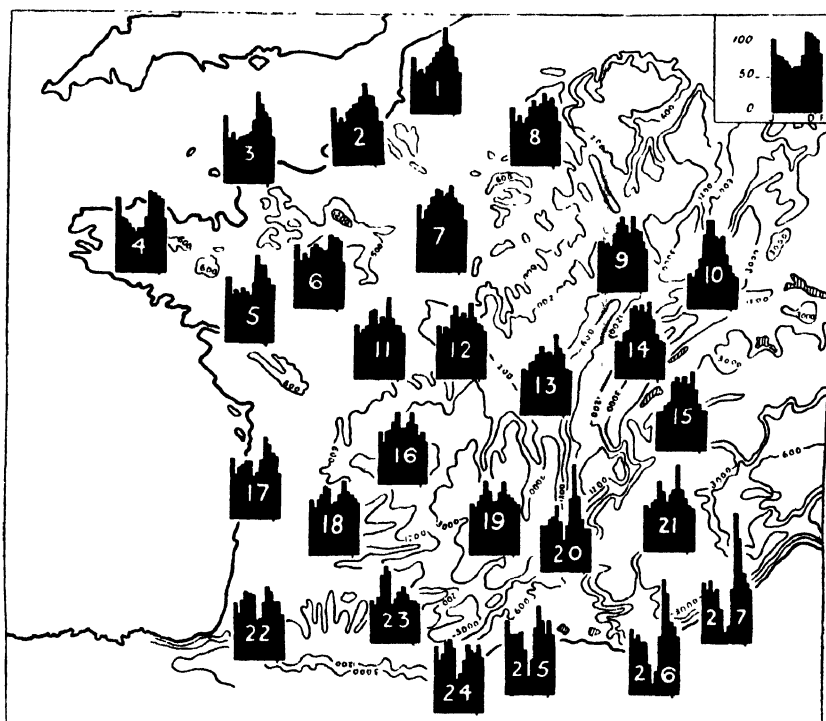


FIG. 8. THE GRAPHS INDICATE PLUVIOMETRICAL FRACTIONS (AFTER ANGOT) FOR EACH MONTH, IN THOUSANDTHS OF THE TOTAL ANNUAL RAINFALL, FOR TYPICAL DEPARTMENTS

- | | | | |
|--------------------|-------------------|-----------------|--------------------------------|
| 1 Pas de Calais | 8 Ardennes | 15 Haute-Savoie | 22 Basses-Pyrénées |
| 2 Seine-Inférieure | 9 Haute-Marne | 16 Creuse | 23 Haute-Garonne |
| 3 Manche | 10 Haut-Rhin | 17 Gironde | 24 Aude |
| 4 Finistère | 11 Indre | 18 Dordogne | 25 Hérault |
| 5 Loire-Inférieur | 12 Cher | 19 Cantal | 26 Var |
| 6 Mayenne | 13 Saône-et-Loire | 20 Ardèche | 27 Alpes Maritimes |
| 7 Seine-et-Oise | 14 Haute-Saône | 21 Isère | <i>Contour heights in feet</i> |

than in the summer half year, although a sufficient number pass in the summer to give a considerable rainfall in that period too. The maximum in autumn may be attributed in part to the equinoctial disturbances in the atmospheric layers, but is also partly accounted for by the fact that the atmosphere contains a greater amount of water-vapour at the beginning of the cold season, and therefore, though rain is not more frequent in autumn

than in winter, the fall is heavier. Relatively low-lying coastal stations, like Brest and Roscoff get little rain compared with such places as Chateaulin and la Feuillée on the south slopes of the Monts d'Arrée, where the winds, rising against the steep edge of the hills, cause heavy precipitation.

The peninsula of Cotentin, jutting northward and exposing its western coast to the Atlantic winds, gets relatively heavy rains.

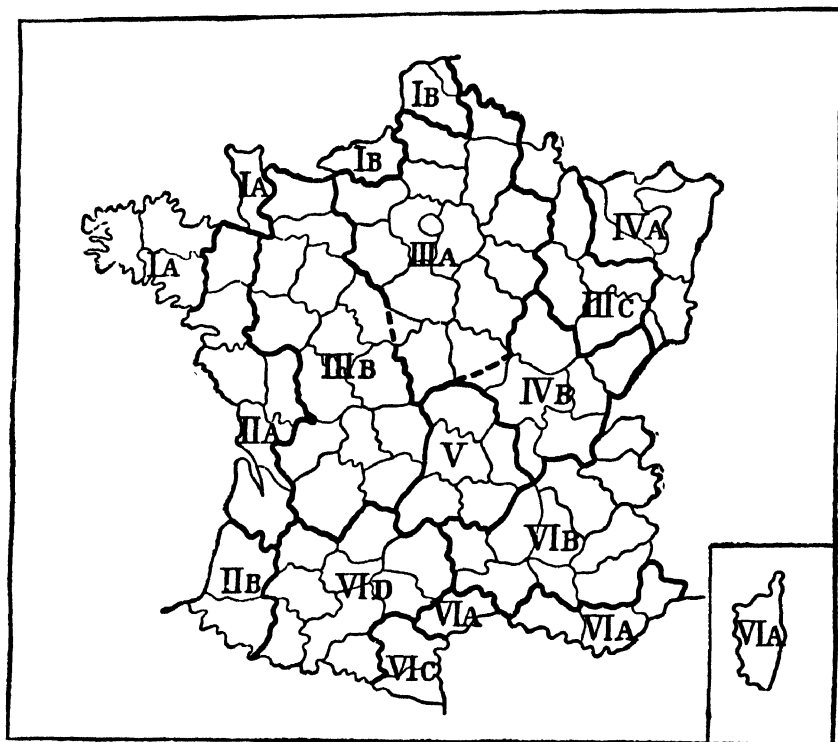


FIG. 9. A SUGGESTED DIVISION OF FRANCE INTO CLIMATIC REGIONS

The department of Calvados, on the other hand, sheltered from Atlantic influences to some extent, does not show the characteristics of the maritime climate to so marked a degree. Seine Inférieure (IB), which forms a promontory north of the Seine estuary, has a modified form of the maritime type of rainfall in that the minimum amount of rain occurs in the spring, after which there is a steady increase in the proportion of rain falling each month until the autumn maximum. This spring minimum may be attributed to occurrence of high-pressure conditions—an

extension of the continental winter high pressure—over Scandinavia and the consequent frequency of inflowing dry air from the north. We find this modified maritime type also in Pas de Calais and the coastal part of the Nord department.

(IIA) Southward from Brittany, along the coast of the Bay of Biscay, there is an increasing tendency towards a secondary concentration of rainfall in early summer, owing to increasing temperature and resultant thunderstorms. The upward curve is at first only faintly indicated; it becomes more marked with the emphasis of spring and late summer dry conditions. February stands out with a secondary minimum. As we approach the Pyrenees we find that there is a notable increase in the amount of precipitation, due to north-westerly and westerly winds in contact with the Pyrenees, and definite drought in summer, with late spring and autumn rains. This high precipitation on the sea border is exceptional, and in conjunction with the definite drought in summer distinguishes the two departments of subsection IIB from those of subsection IIA.

The Paris basin (section IIIA) has a type of climate which exhibits in a modified form the continental or central European type. The winters are notably colder than those of the coastlands (30.7° F. as against 45° at Roscoff and 39° at Fécamp). The summer average is relatively high— 62° to 65° , the same as that of Nantes, which lies three degrees to the south. The average range is 21.5° , but the absolute range is very high. With regard to rainfall, the mean annual amount is relatively low, about equal to that of the department of Aude. The climate is further characterized by a dry spring and maximum precipitation in early summer and autumn in nearly equal proportions. July and August are relatively dry months. We see, then, that the climate of the Paris basin exhibits distinct continental traits and that Atlantic influence is beginning to wane, 60 per cent of the rainfall occurring in the summer months. The average range of temperature is at least 10° higher than on the coast, and the difference in absolute range is as much as 30° .¹

There is a broad transition zone (No. IIIB) between the coastlands and the departments which exhibit markedly the traits of the Paris basin climate. Here, although there is a clearly marked secondary maximum in summer, the average autumn rainfall is still higher than the summer rainfall. In this zone there is transition also southwards, the summer drought becoming gradually more noticeable. The line of demarcation is perforce arbitrary.

In section IVA, which includes the plateau of Lorraine and

¹ Hahn: *Handbuch der Klimatologie*, Vol. III, p. 190.

part of the Rhine Rift valley, continental conditions are definitely established. The temperature exhibits extremes which are much more marked than those of the Paris basin, and precipitation takes place mainly in summer, the maximum being in June, except in Bas Rhin, where it occurs in July. Winter in the Vosges is long and harsh, spring and autumn short and uncertain.

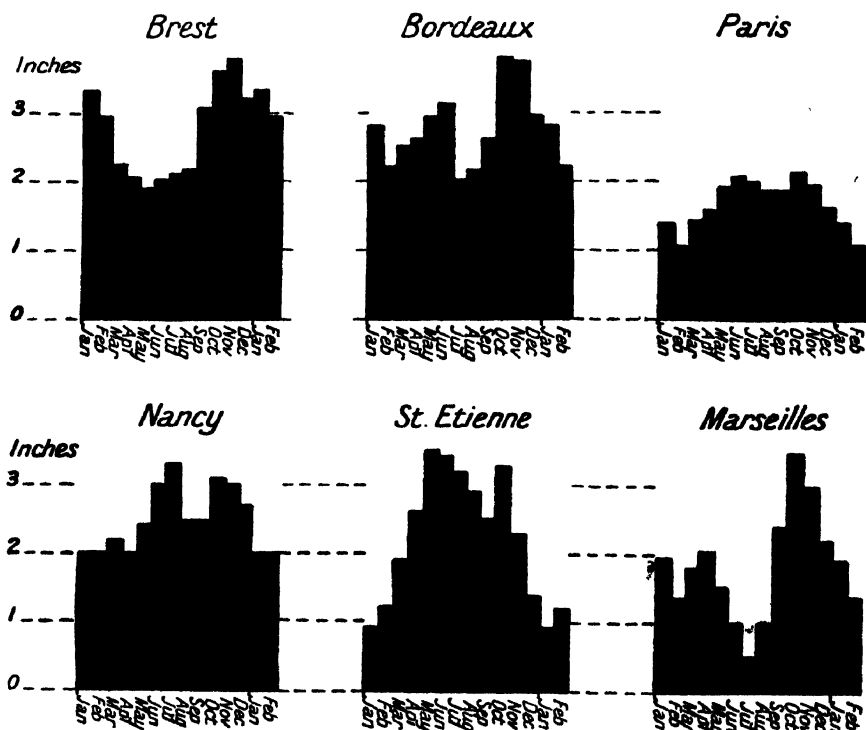


FIG. 10. TYPICAL RAINFALL GRAPHS, SHOWING THE RELATIVELY HEAVY RAINFALL WITH MARKED WINTER MAXIMUM OF THE MARITIME TYPE, MODIFIED IN THE SOUTH BY A SECONDARY MAXIMUM IN JUNE DUE TO THUNDER-STORMS. THE TRANSITION TOWARDS THE CONTINENTAL TYPE IS SHOWN IN THE PARIS GRAPH.

In the Rhine plain, which lies in the rain-shadow of the Vosges, with descending winds, the climate is sunnier, the temperature range relatively great, from about 33° to about 67° , and the rainfall is low.

Between this region and the floor of the Paris basin lies an area (IIIc) in which conditions resemble those of the Paris basin except that, owing to elevation, the annual rainfall is heavier, that temperatures are lower throughout the year, only five

months having an annual temperature of over 50° , and that here the rainfall, instead of reaching its maximum in the summer, as one might expect in passing east of Paris, is greatest in October. This is due to the sudden elevation, which neutralizes the effect of distance from the sea by causing the winds to precipitate a large proportion of their moisture as they are forced suddenly to rise at a season when they are most nearly saturated with water.¹ In addition, owing also to altitude, which lowers the temperature, summer storms are less violent. The general effect is seen clearly in Figs. 3 and 4, where the Paris basin stands out as an area of relatively low precipitation, ringed about by more rainy regions, where the precipitation shows maritime characteristics. But for the elevation of the rim of the plateau from the hills of Artois to the Jura, the precipitation would be progressively more continental in type.

South of the plateau of Lorraine the upper Saône basin forms a further subdivision (IVB). Here the altitude again throws the major maximum into October, a secondary one occurring, however, in May and June. January has the least precipitation, which generally takes the form of snow.

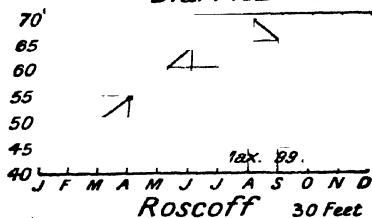
The northern Central Massif has a climate of its own (V). In the departments of Allier, Cantal, Loire, Haute Loire, and Puy de Dôme the bulk of the rainfall occurs from May to October, with a slight peak in each of those two months; there are minima in February and August, and January is generally a dry month, particularly in the intermontane basins. The amount of precipitation varies with altitude and aspect and the rainfall decreases from October to February, rising again from February to June. There is a slight drop in September. In the Allier basin the summer maximum is in June, not in May.

The truly Mediterranean type of climate with its characteristic period of drought in summer is confined to the coast, and only occurs in the departments of Hérault, Bouches du Rhône, Var, Alpes Maritimes, and Corsica (VIA). A modified type of Mediterranean rain distribution is found in the middle and lower Rhône basins including the southern Alps (VIB). In both divisions there is a marked period of dry weather in summer, reaching the minimum in July. As the rainfall increases in summer in Auvergne so it diminishes in Provence. The maximum rainfall is in October, December being relatively dry. The other characteristic feature is the massing of the rainfall in the autumn and winter months. On the coastland there is no rain in June and July. Aude and Roussillon are very dry in July, precipitation being .8 inches, owing to the frequent blowing

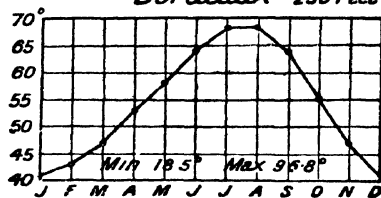
¹ See p. 13.

Average actual Temperatures. Fahrenheit

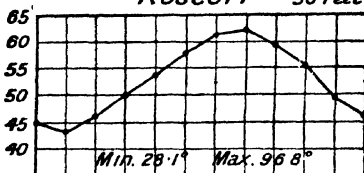
Biarritz 115 Feet (above
Sea Level)



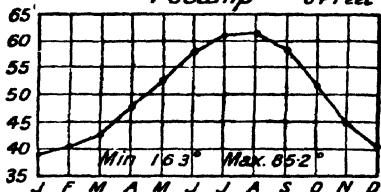
Bordeaux 250 Feet



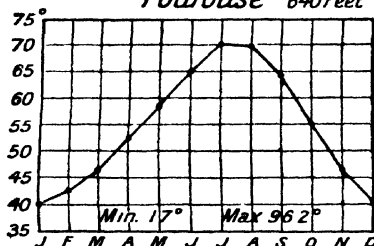
Roscoff 30 Feet



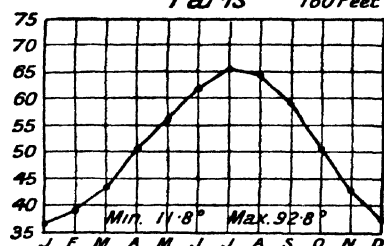
Fécamp 64 Feet



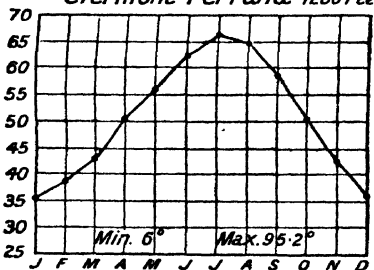
Toulouse 640 Feet



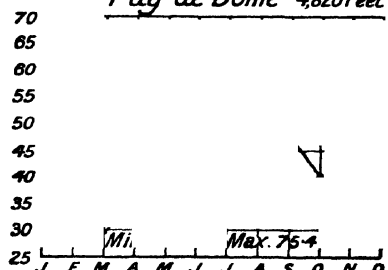
Paris 160 Feet



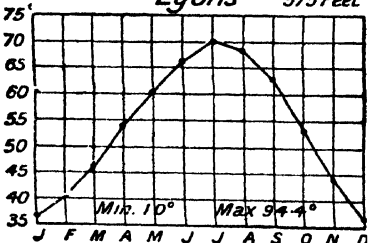
Clermont-Ferrand 1280 Feet



Puy de Dôme 4,820 Feet



Lyons 575 Feet



Montpellier 115 Feet

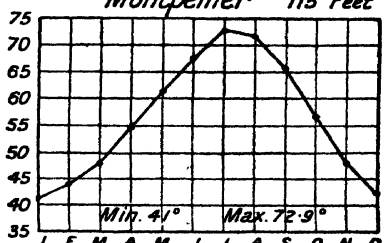


FIG. II. TYPICAL TEMPERATURE GRAPHS.

NOTE : THE METEOROLOGICAL STATION AT BORDEAUX LIES ON THE HIGH GROUND TO THE EAST OF THE RIVER.

of the tramontane. The heavy spring rainfall, usually heavier than that of autumn, makes it necessary to assign this type to another subdivision (VIc).

A transition type (VID), which is found in the central Pyrenees and south-western Central Massif, the Aquitaine climate, is peculiar for its three months' rain in April, May and June. May is the month of absolute maximum for most stations in this division.

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Air Force Climatological Atlas of the Mediterranean.

PART II
REGIONAL STUDIES

PART II

REGIONAL STUDIES

CHAPTER II

THE CENTRAL MASSIF

The Loire and the Eastern Massif—The Allier and the Auvergne Highlands and Basins—The Cher, the Creuse, and the Plateaux of Combrailles and Marche—The Vienne and the Limousin Plateaux

THE Central Massif, or Interior Massif, as it might more justifiably be called, is a four-sided block of upland of an average height of 3,000 feet above sea-level, which occupies the greater part of south central France. It rises steeply from the lowlands of Provence and from the plain of the Saône, but dips more gently north-westward and south-westward to the basins of Paris and Aquitaine.

Its characteristic features are due in the main to the structure of the rocks, and reflect very closely certain outstanding features of its geological history. The Massif is a relic of the southern portion of the great Hercynian mountain system which rose towards the end of the Carboniferous period and stretched east and west across what is now Europe. Two great systems of Hercynian ranges trending, the one from north-west to south-east and the other from north-east to south-west, converged upon one another in what is now south central France. For long ages this crumpled mountain mass was subjected to sub-aerial erosion. It suffered also fracturing and re-elevation, so that it rose as an island from surrounding seas, which penetrated now from the direction of the Atlantic, now from that of the Mediterranean. Of sedimentary rocks older than the Carboniferous, the Central Massif shows very little trace. There is little evidence as to the extent of their deposition and erosion. During the Carboniferous period, however, earth movements took place which resulted in the formation of depressions along lines of faulting and folding. In these depressions lakes or lagoons were formed, in which, during the Upper Carboniferous period, great thicknesses of sands, shales, conglomerates, and coal were laid down. The deposits continued to form and increase in thickness as the displacement continued, and took part to some extent in the later

unconformably and almost horizontally upon the Carboniferous deposits. Volcanic action appears to have been more or less continuous during the Carboniferous period, for we find volcanic material frequently associated with the small coal-fields that lie upon the flanks of the Massif.

After the Permian period the Central Massif area seems to have entered upon a long period of rest, which was undisturbed, save for slight movements that modified to a minor extent the coastline, until Tertiary times.

The broad result of the complicated history that we have very briefly summarized was the reduction of the elaborate system of Hercynian mountain ranges to a peneplane, a condition which marks the end of the second stage in the development of the Massif.

The third stage begins in the Tertiary period, when the tremendous earth movements took place which folded up the sea bottom over a vast zone along the line of the Mediterranean and produced the mighty ranges of the Alps and Pyrenees. The ancient peneplane, the core of the older mountain system, formed of ancient rocks, molten and crystallized under enormous pressure, constituted a great resistant mass which checked the waves of the new earth movements and diverted their lines of folding. In its unyielding rigidity, however, the Massif suffered both fracture and upheaval. The great block was raised once more, its fractured edges rising high to the east and south, from which aspects even to-day they have the appearance of mountain walls. In its upheaval it carried with it the limestone floor of the seas that washed its flanks, so that an almost complete ring of limestone plateaux of Jurassic or Cretaceous age surrounds the block of archæan rocks. Great cracks let down the floor of the lower Rhône basin along the line of contact of the Alpine and Pyrenean folding. Here and there more or less parallel lines of faulting within the Massif resulted in broad depressions at a relatively low level. Strings of such tectonic basins, separated by horsts, lie along the lines of the upper Loire and Allier. During this third stage in the making of the Central Massif vast streams of lava were poured out from the vents in the surface of the re-elevated plateau, and a line of volcanoes came into being along the western edge of the series of tectonic basins through which the Allier flows.

From the beginning of the re-elevation of the worn-down peneplane sub-aerial erosion set in, of course, with renewed energy, and, naturally, the newly forming volcanoes and lava plains were included in its action. There resulted, at last, a much-dissected plateau of ancient crystalline rocks, surmounted

here and there by masses of volcanic rock—ruins of volcanoes represented by fragments of crater edges and scores of volcanic necks from which the softer materials had been worn away. Such remnants may be seen in the line of the Puys to the west of Clermont-Ferrand and the great cone of the Cantal farther to the south.

Glaciation also has had a hand in the shaping of the contours of the Central Massif. Great glaciers covered the volcanic heights until late Quaternary times, hastening the erosion of the peaks and filling up the craters, valleys, and basins with detritus. As the ice departed, glacial flood waters scored deep channels in the plateau cover of lava that remained and etched deep into the crystalline rocks beneath, tearing away enormous quantities of detritus that was deposited in the tectonic basins and on the lower flanks of the plateau.

(Thus was formed the great crystalline plateau that we know to-day, with its cincture of limestone, its abrupt southern and eastern edges, its gentler northern and western slopes, its interior basins, its lava platforms, and volcanic bosses.)

The Massif forms a definite geographical unit by reason of its abrupt edges, its elevation, the coarsely crystalline nature of its rocks, their general impermeability, the resulting complicated network of watercourses, and the acidity and poverty of the soils, which, in their turn give rise to a distinctive vegetation). Nevertheless, the variations in relief and land form resulting from the complicated geological history of the Massif, and the climatic variations due to the differences of altitude and aspect, have given rise to a number of contrasting sub-regions sufficiently marked in character, both by their physical conditions and their development under human occupation, to bear distinctive names. Such names are descriptive of natural conditions as the *Causses* or the plateau of Millevaches (thousand springs), of agricultural conditions, as *ségalas*, or are names related to settlement, as *Limousin*.

Generally speaking, the main platform of the Massif is composed of crystalline schists and gneisses. The edge rises high to the south-east in the Cévennes and the Vivarais, and slopes gently north-west and west. In the Cévennes the altitude varies from 2,000 to 5,000 feet. In the plateau of Gévaudan, which lies between the Cévennes and the Cantal, the average height is about 3,800 feet. In Limousin, to the west, it is only about 1,000 feet. This platform of archæan rocks is surmounted by ridges and bosses of granite, forming high-level plateaux which rise above the lower crystalline plateaux by an average of 1,500 feet. These flat-topped domes and ridges usually form the water partings

between the main stream-systems, and are frequently bounded by lines of fracture, as in the instance of the north to south ridges that separate the tectonic basins of the Loire and Allier : the Forez, Livradois, and Madeleine uplands. West of Auvergne, the high granite plateau of Millevaches overlooks the gneiss and schist plateau of Limousin. To the north the Combraille plateau drops sharply to the Sologne Bourbonnaise and dips beneath the coal furrow of Montluçon. Jutting northwards into the Paris basin from the north-eastern corner of the Massif, the great block of the Morvan drains to the Seine, Rhône, and Loire. Sharply differentiated in their bizarre forms, the volcanic cones and plateaux spring from the crystalline platform. The Auvergne highlands, with their sheets of basalt and their upstanding volcanic necks, run north and south through the centre of the Massif. The great Puy de Dôme and the line of the lesser Puys overlook the tectonic basin of Limagne and trend southwards to the vast, spreading cone of the Cantal, whence the line of eruptive rocks can be traced in the Monts d'Aubrac and the Escandorgues. In Velay and Vivarais, east of the Cantal, great sheets of volcanic rock lie upon a platform of granite. Remnants of lava dikes stand up in pinnacles from the floor of the tectonic basin of Le Puy, which lies between the two volcanic uplands. The Montagnes des Coirons are another remnant lying upon the limestones that flank the south-eastern slopes of the Cévennes, and volcanic evidence can be traced along the fractured edge of the Massif to the coast, where the volcano of the Montagne d'Agde forms a jutting promontory which breaks the smooth contours of the gulf of the Lion to the south-west of Sète.

The outstanding uplands, then, correspond, generally, to the occurrence of masses of granite or to volcanic outpourings in the form of lava sheets or dikes or actual volcanoes. The lower plateaux usually correspond to areas of schist and gneiss.

The depressions, due to ancient synclines infolding sedimentary rocks and the tectonic Tertiary basins floored with ancient and recent alluvium form entities of another and, from the point of view of human settlement, more important type. Near the sources of the Loire the basin of Le Puy forms an oasis of relatively prosperous settlement. Farther down, the plains of Forez and Roanne succeed each other, separated by great horsts of granite. Along the Allier valley a chain of smaller basins leads down to the great fertile plain of Limagne, which in turn opens to the Sologne Bourbonnaise. Of vital importance to the life of the eastern section of the Massif are the ancient¹ synclines, the

¹ Carboniferous.

erosion of whose soft deposits have provided lines of communication between the valleys of Rhône and Loire and whose coal

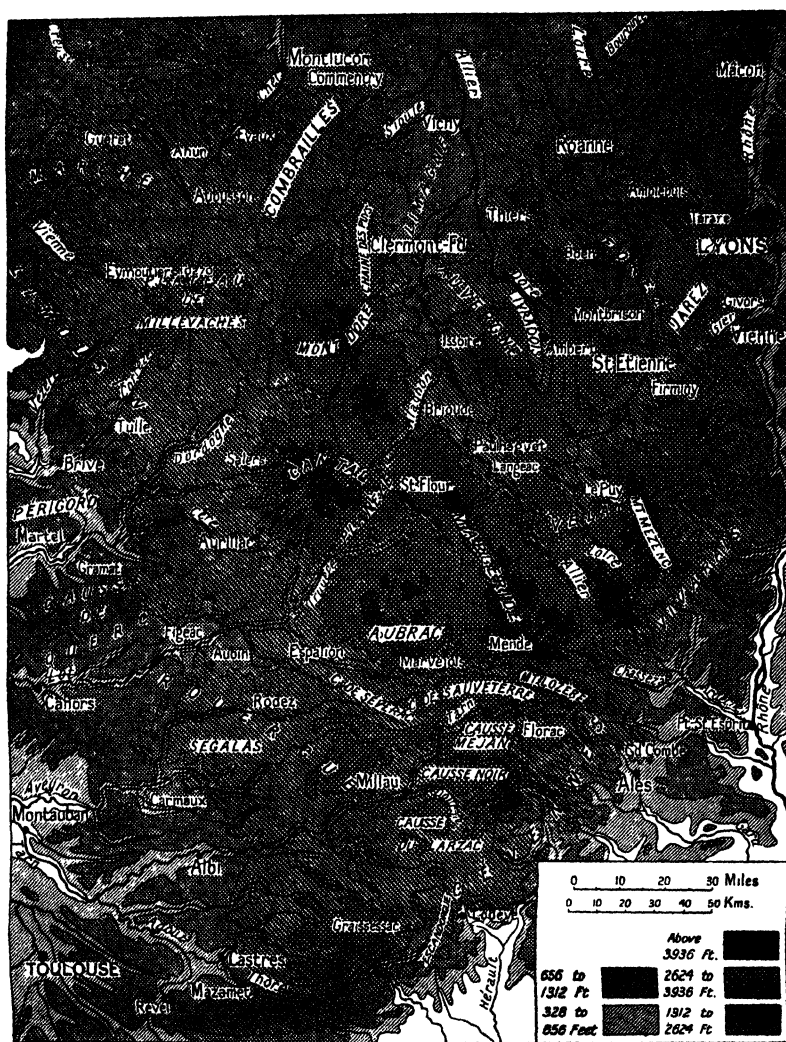


FIG. 13. THE CENTRAL MASSIF

measures have led to the establishment of industries. Of these Jarez, with St. Etienne, and Autunois with le Creusot, form definite *pays*.

Finally we have the encircling zone of Jurassic limestone

forming great isolated blocks of karst land in the south and south-west, as in the Causses of Larzac and Quercy, separated generally from the surrounding uplands of crystalline rock by deep, narrow vales of Lias clay. In the north the limestone belt of the Champagne Berrichonne forms the southern rim of the Paris basin, and the fractured edge of the Massif rises abruptly above the deep Lias vale of the Black Valley.

Although the Massif is an obstacle to communication from every direction, it is more difficult to cross from west to east and vice versa than from north to south. There is nothing surprising in this, in spite of the fact that the land rises towards the south and that to reach the Midi the Cévennes have to be crossed, for the zones of crystalline plateau, low-lying plain and volcanic masses, are, generally speaking, aligned in a north to south direction. So that to get from Bordeaux to the Rhône trench one has to cross, first, the broad crystalline uplands of Limousin, rising eastwards into bleak moors; then the high plateau of Millevaches, where the main roads rise to over 2,400 feet; then the plateau of Auvergne, with a rise to over 3,000 feet; after which the descent is abrupt into the basin of the Allier. On the other side of the basin the steep-edged Forez plateau, crossed by only one road, must be traversed. Beyond comes the sudden drop to the valley of the Loire, and finally the plateau of Jarez must be negotiated via St. Etienne or Roanne before the descent of the winding valley of the Gier can be made to Givors or Lyons.¹

In a north to south direction the valleys of the Loire and Allier, with their relatively densely-peopled plains, lead from Paris and Orleans, via Clermont Ferrand or Roanne, some 124 miles into the heart of the Massif, before the road rises much above 3,000 feet above sea-level. But the innumerable deeply-trenched side valleys that have to be crossed and the occasionally marshy nature of the plain have presented obstacles to railway construction. Bridges and tunnels are traversed constantly, and gradients are difficult. One day the French will exploit commercially the wild and beautiful scenery of the Auvergne and the Cévennes, and then the beautiful viaducts that span the lonely valleys will acquire a new economic significance; but the fact remains that it takes twice as long to travel by train from Paris to Marseilles via the Central Massif as it does to make the détour through the Saône-Rhône valley.

The national roads and many of the secondary roads through the upland are very good, except where they narrow to almost

¹ The express service from Bordeaux to Lyons makes a détour northwards via Montluçon and Roanne.

impassable alleys in the villages. The gradients are easy at the expense of many hairpin bends, for the roads have to descend the numerous deep valleys to the bottom and to climb the steep opposite slope every time a bridge has to be crossed. The actual distance to be travelled by road is often double the distance as the crow flies. Nevertheless, with the development of motor transport, these winding and twisting roads are becoming more and more utilized, and the journey across the Cévennes from Le Puy is no longer a formidable affair, except in the depths of winter. True, the passes are sometimes completely blocked by snow. The Col de la République, which carries the *route nationale* from St. Etienne to the Rhône via Bourg Argental, is frequently impassable from the beginning of January to the middle of February; but the passes in the Jura are sometimes blocked for three months at a stretch. The railway from Clermont to Alès is protected on the higher summits from the snow by wooden structures.

Climatically, the Central Massif plays an important rôle as the divide between regions of Atlantic and continental conditions to the north, and Mediterranean conditions to the south.¹ Owing to its generally high elevation it may also be said to have characteristic climatic conditions of its own. These cannot be termed Atlantic in type, for the maximum rainfall occurs in the summer half year. It is not Mediterranean, for, although there is a tendency to spring and autumn maxima, complete drought in any summer month is rare. Although bearing strong resemblances to the continental type as regards the seasonal distribution of rainfall, the total amount of rainfall and the general humidity are too high, and there is no marked winter drought. In winter the upland is bleak, on the whole. Temperature, of course, varies with altitude, but in the Cévennes snow lies for three or four months every year. The deep valleys, also, are cold in winter, partly owing to the small amount of direct sunshine they receive and partly to the creeping down of cold air from the uplands. The enclosed basins within the Massif have continental temperature conditions, being warmer in summer, because of their lesser elevation and because of the prevalent descending dry winds and the clear skies, and cold and sunny in winter, because of the collecting of heavy, cold air and relatively rapid radiation of heat. The effect of altitude on temperature is in some districts counterbalanced by the heat-retaining qualities of the soil. The warm, dark basalt soils of the Auvergne, and the warm, dry porous soils of the Causses, carry a much greater variety of crops than the cold soils of the crystalline

¹ See Chap. I, pp. 8 and 21.

uplands, for this reason. Rainfall is naturally heaviest on the higher land ; ¹ but aspect is a very important factor in its distribution. Northern and western slopes, facing the prevailing winds, are much wetter than eastern and southern ones. Aspect is an important factor also as regards temperature. Whereas on the northward-facing plateau above 2,000 feet very little but woodland and rough pasture is to be met with, and the cereals grown are mainly rye or buckwheat, at a similar altitude on the southern slopes mulberry trees, early vegetables, table fruits, and the vine can be grown.

The distribution of population and of occupations in the Central Massif is dependent mainly on altitude, which affects the temperature and rainfall, and on facilities of communication, and to a less extent upon soil and aspect, water supply and fuel. We find that the high plateaux lying at levels between 3,000 and 4,000 feet, such as Forez and Livradois and the plateau of Millevaches, are sparsely populated, while the plateau of Bas Limousin, 1,100 feet above sea-level, has a population of 119 to the square mile. Sometimes the effects of elevation are counteracted by excellence of soil, as in the Cantal, where the rich soils arising from the disintegration of volcanic rock give a markedly increased density of population. Even at 3,600 and 4,000 feet the average density rises to thirty persons per square kilometre. Again, comparative ease of communication has resulted in a string of small towns and large villages along the valleys of the Loire and Allier, while a down-wash of rich volcanic soils in the basins of Clermont-Ferrand (Limagne), and Le Puy have led to dense agricultural settlement, in contrast to the less fertile and more sparsely settled Forez basin. As one would expect, aspect, having an important effect on crops, affects also density of population. The sunny aspect of the southern slopes of the Cévennes make it worth while to terrace the steep sides of the valleys for cultivation and to irrigate the upper basins of the tributary streams. Thus we find a rugged country, only accessible with difficulty, supporting a relatively dense population.)

The divergent trend of the valleys means that there can be no great central nodal point within the Massif, although the tectonic basins of the Loire and Allier afford relatively easy lines of penetration. The chief gathering-points lie near the periphery at the junction of upland and plain.

It is clear, then, that in the Central Massif we have a region which, although generally speaking it plays a negative rôle in the human geography of the country, being a serious barrier to communications and, on the whole, inimical to cultivation, yet,

¹ Rainfall map, p. 10.

owing to accidents of relief and soil, affords a surprising variety of landscape, settlement, and occupation.

Let us now consider in detail some of the typical *pays* of the Massif as we follow the courses of the major streams from upland to plain.

THE LOIRE AND THE EASTERN MASSIF

The head-streams of the Loire rise in the south-eastern extremity of the Massif, in or near the culminating ridges of the block. The tributary that has assumed the name of the main river rises within thirty miles of the Rhône. The Allier valley has penetrated farther south, and lies within thirty miles of the southern rim of the upland. The two rivers pass through landscapes so dissimilar that a comparative description of their courses will serve to give a good idea of the characteristic features of a great part of the plateau.

The Loire takes its rise in the volcanic (phonolite) block of the Mont Mezenc, in the Monts du Vivarais, at an altitude of some 4,600 feet above sea-level. It reaches the plain of Bourbonnais after traversing a series of basins separated from one another by ridges through which the river has cut its way, sometimes by gorge-like passages. In the upper part of its course the Loire has eroded its basin in a great mass of basaltic and phonolitic rock, which in the south it has to a great extent worn away, exposing the granite beneath and leaving only remnants of basalt and other and harder volcanic rock capping the hills that surround the head of the basin, e.g. the Suc de Banzon and the Forêt de Mazan, both rising to nearly 5,000 feet. The chief source of the river is to be found on the slopes of the Gerbier de Jonc, some six miles to the south of the great cone of the Mezenc, the highest of the volcanic mountains of the Central Massif. The fissured basalt here gives rise, except after a period of drought, to innumerable springs. At the foot of the Gerbier de Jonc the infant Loire plunges some 1,000 feet in the first six miles. It travels at first south-west, following one of the numerous lines of fracture so characteristic of the region.¹ At the foot of the volcanic Suc de Banzon it turns at right angles to travel north-north-west across a granite plateau covered only by a waste of moor, which offers a scanty pasture for cattle in the summer. Six miles farther north, to the right of the valley, the Lac d'Issarles occupies the crater of an extinct volcano. The bare moorland reminds one of the open wastes of Dartmoor.

THE BASIN OF LE PUY. A little farther on the river enters

¹ Gallouédéc: *La Loire*, p. 76.

a Tertiary tectonic basin, partly filled with sediments washed from the surrounding plateau and partly with local extrusions of lava and with lava flows from neighbouring volcanoes.¹) The Mezenc Massif shuts in this basin on the east and separates it from Vivarais, while the Monts du Velay, rising to over 4,600 feet, close it in on the west. The substructure of the basin, exposed where the eroding streams have cut down into it, is formed in the main of granite, covered with Tertiary limestone, clays, and marls; some of them, e.g. the Pliocene sands, form layers 300 feet thick. Upon these sedimentary deposits rise blocks and mounds of volcanic rock, which owe their preservation to their being harder than the rest of the formation to which they belong. These deposits rise in terraces above the Loire. A well-developed stream-system has dissected the floor of the basin, exposing the crystalline rocks beneath and carving the overlying deposits into steep, cliff-edged masses, which are here and there surmounted by blocks and pinnacles of basalt. Many of these basaltic masses are thickly wooded. The landscape is grotesque and fantastic rather than beautiful. Farms, isolated or in groups, hamlets and villages are scattered thickly, rarely at intervals of more than a mile from one another. They are situated more often than not on the upland above the valleys, and frequently two or three miles from a road of any importance. The even distribution of the villages and farms and the absence of large groupings reflect the comparative fertility of the soil and the abundance of springs in the basalt rock, which makes the construction of costly wells or tanks unnecessary. Cultivation is carried on in patches on the upper and gentler slopes, the steep sides of the deeply-entrenched valleys being generally wooded and the valley bottoms having little room for anything but the torrent itself, particularly in flood-time. Therefore roads avoid the valleys where possible, only winding down the slopes from time to time² to cross a bridge, and the deep gorges are almost deserted. There are no population centres of any importance except le Puy. Where the granite is exposed over a large area, the population is much less evenly distributed than on the basalt. Isolated farms are few. Villages and hamlets are separated by three or four miles from one another.

(Le Puy, the market town of the district and the *chef-lieu* of the department of Haute-Loire, lies near the northern edge of the basin on the river Borne, about a mile from its junction with the Loire. The *route nationale* from Clermont-Ferrand and that

¹ O. Barré: *L'Architecture du sol de la France*, p. 328.

² E. Chaput, D. es Sc.: 'Les Variations de Niveau de la Loire et de ses affluents' (*A. de G.*, January, 1919).

from Ambert unite about six miles to the north-west, and the road winds steeply down into the basin past the village and château of Polignac. The effect of erosion on the volcanic and sedimentary floor of the basin is bizarre in the extreme. The old town is situated on a volcanic mass crowned by the pinnacle of the Rocher Corneille. Built on to the base of the rock is the cathedral, which dates back to the eleventh century. Its façade is ornamented with a chequered pattern in blocks of white limestone and black basalt. From the summit of the rock behind the cathedral a magnificent view can be obtained of the whole basin, and beyond it of the line of volcanic heights of the Puy de Dôme to the north and of the Cantal to the west, of the Mont Mezenc bounding the horizon to the south-east and the volcanic block of the Forêt de Banzon to the south. The eye ranges over ridge behind ridge of hills, welling up like the waves of the sea. On the slopes of the nearer hills the vineyards can be seen running up to the edge of the woodland, and the cultivated fields, dotted with farms and groups of farms at the foot of the slopes. Down below, on the flat lies the modern town, with its public gardens and boulevards. Sheer from the flood-plain of the Borne, to a height of about 260 feet, rises the towering pinnacle of volcanic rock whose summit bears the small chapel of St. Michel, approached by many steep flights of steps; and beyond, the château of Polignac rears its massive ruins on a block of columnar basalt. Le Puy had a population of 18,360 in 1936.¹ There has been a gradual drift from the rural districts to the market town, and from the town to more industrially developed regions. The silk and other textile industries of the upland to the west of St. Etienne have no doubt been a source of attraction. So also have the rapidly-developing metallurgical and rubber industries of Clermont-Ferrand. Le Puy is the centre of an ancient lace-making industry, by which the women-folk seek to supplement the meagre takings of the farm. One can still see the women and girls of the villages round le Puy busy at the cottage doors in the summer with their pillows and bobbins. The town itself counts lace-making as its chief industry, and it is the distributing centre for the raw material and the collecting centre and market for the finished product. All kinds of lace are made from fine *lingerie* lace to coarse Cluny lace for blinds, curtains, etc. The development of machine lace-making has dealt a hard blow to the mountain industry.

The Loire now cuts through a granite horst 2,300 to 3,300 feet above sea-level, which separates the basin of Velay or Le Puy from the basin of Forez. It leaves the Le Puy basin by the winding and beautiful gorge of Peyredeyre, in which it is closely

¹ Note.—All population figures are given in terms of the '*population municipale*.'

accompanied by the railway.) The valley trends north and north-east to within six miles of St. Etienne, assuming the Hercynian trend which is taken up also by its tributary, the Ance. Craponne-sur-Arzon is the chief commune of the Forez upland, with a population of 3,219 inhabitants. A zone of relatively dense population extends north-east from Craponne-sur-Arzon, to St. Etienne, parallel to the Loire. The settlements of this district are all engaged in lace-making. The river Loire itself passes through a comparatively desolate part of the plateau, where, although a single-track railway accompanies it, by the aid of cuttings, tunnels, and viaducts innumerable, it is followed by no road of any importance. The main road from Le Puy to St. Etienne, on the other hand, passes via Yssingeaux, avoiding the valleys.

Near Unieux, the Loire receives the Ondaine from Jarez, and crosses the western end of the St. Etienne coal-furrow. Here the metallurgical centre of Firminy with le Chambon are outliers of the St. Etienne area.¹ The Loire now proceeds north in a series of winding gorges which finally open into the drained-out Tertiary lake-basin of Forez, which lies at a little over 1,000 feet above sea-level.

FOREZ. The plain of Forez is twenty miles long and ten to twelve miles across. It is supposed to derive its name from Feurs, on the Loire, a small town which occupies the site of a Romano-Gallic centre (Forum Segusianorum). The Beaujolais uplands end in a steep brink along its eastern edge; the Monts du Forez drop to a series of terraced spurs, trenched by innumerable streams, on the west. The Loire hugs its right-hand border, as also do the road and railway. It is filled with Tertiary lacustrine deposits of marls, sands and clays, into which the river has trenched its course. Bands of ancient and recent alluvium cover terraces which record the various levels at which the river flowed in former periods.² The level spread of the clay which covers large areas has produced a waterlogged condition of surface and an uncertainty of drainage which has been inimical to settlement. Among the marshlands that cover so much of the surface of the plain the population is sparse; only in the south, where the influence of the St. Etienne coal-field is felt, or where, along the edges of the basin, east and west routes cross the main road, or where a bridge spans the Loire, do we find settlements with a population of as much as 3,000.

Montbrison, which stands on a lofty and steep volcanic mass, like Montrond on the opposite side of the basin, lies on the south-western rim. Through it pass rail and road from Clermont, via

¹ See p. 290, and Fig. 55.

² Gallouédec: *La Loire*, p. 253.

Thiers and Boën. Boën, although on the railway and at the junction of five important roads, has a population of only 2,313.

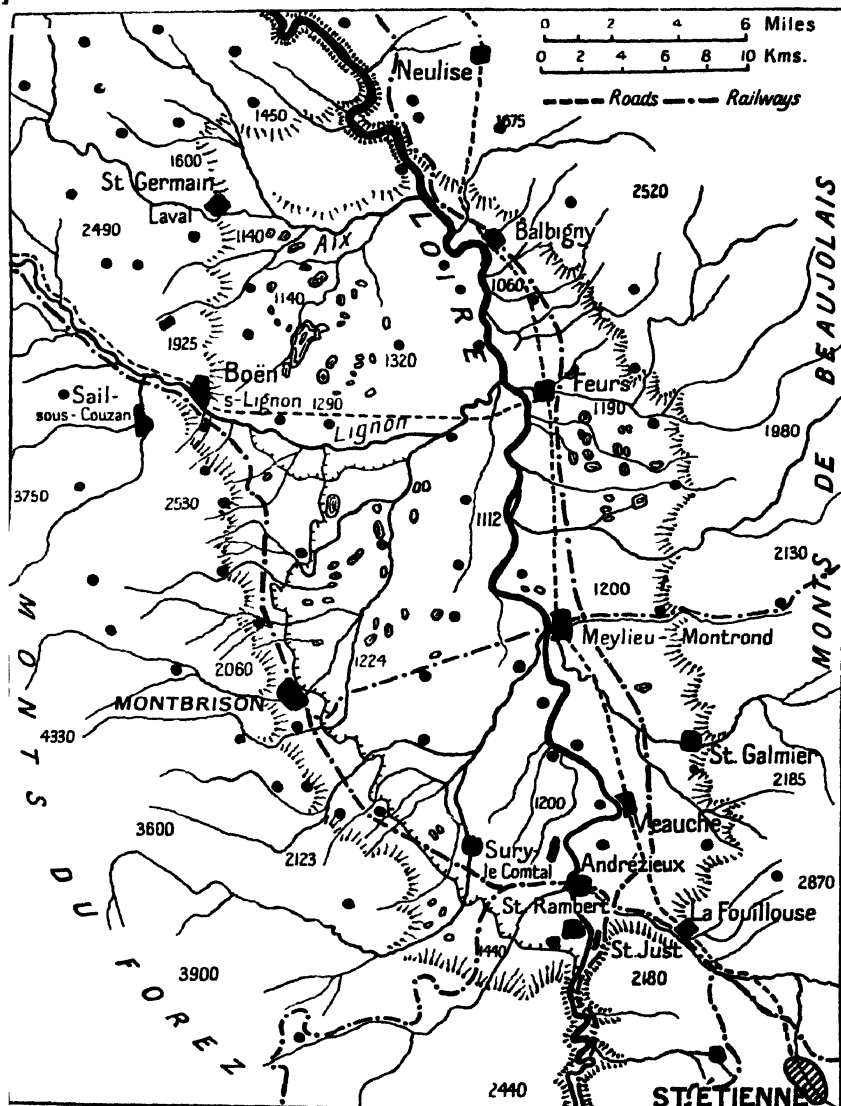


FIG. 14. THE FOREZ BASIN. NOTE THE GORGES BY WHICH THE LOIRE ENTERS AND LEAVES THE PLAIN, THE ILL-DRAINED FLOOR OF THE BASIN, AFFECTING SETTLEMENT, AND THE CROWDING OF VILLAGES IN THE SOUTH UNDER THE INFLUENCE OF THE PROXIMITY OF ST. ETIENNE.

Nevertheless, unlike most of the towns of the basin of the Forez, it has increased in size of late years. The population of

Montbrison has declined in the last fifty years by about 200. It was for generations the capital of Forez, but in modern times has had to cede place to St. Etienne.

ST. ETIENNE. This important town of 186,324 inhabitants in

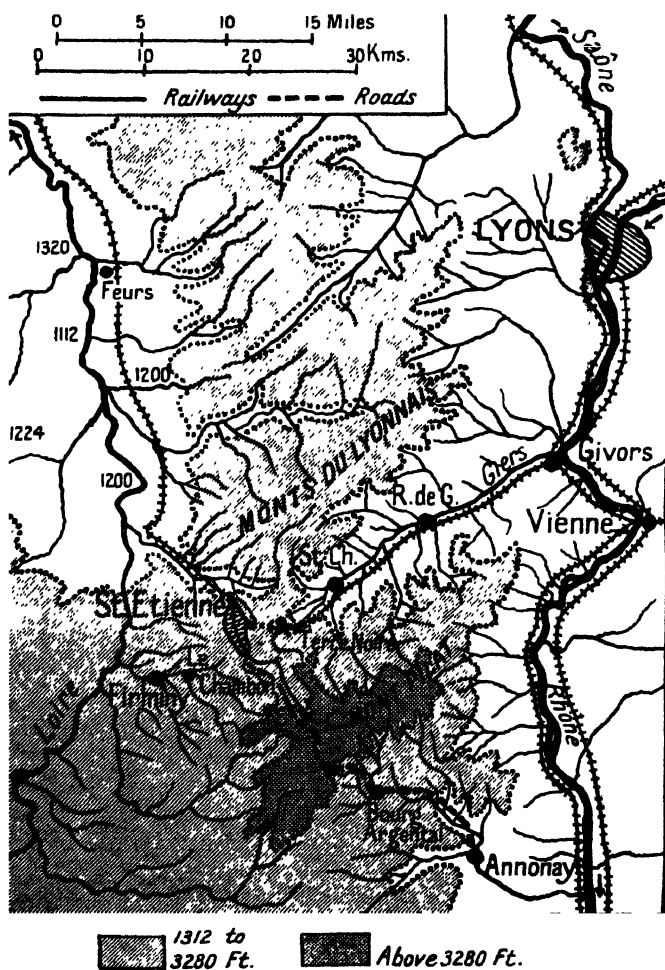


FIG. 15. SHOWS THE RELATION OF THE FOREZ AND JAREZ DISTRICTS TO THE RHÔNE VALLEY AND LYONS. THE DEPRESSIONS CORRESPONDING TO HERCYNIAN SYNCLINALS PROVIDE LINES OF COMMUNICATION.

1936 lies in the Jarez district to the south-east of the Forez basin on the Furens, tributary to the Loire, and for that reason is counted as belonging to Forez, although, economically, it belongs to the Rhône basin. A southwards-projecting spur of the Lyonnais

plateau, which rises to over 3,280 feet, separates it from the valley of the Gier, which flows north-east to join the Rhône.¹ The coal-field, to which St. Etienne owes its development as a metallurgical and textile centre, extends across the divide to a short distance beyond the Rhône, while in the south-west it includes Le Chambon in the Ondaine valley. It is worked between Unieux and Rive-de-Gier. This coal-field, together with the little detached anthracite field of Roanne, is generally referred to as the Loire coal-field. It produces a large proportion—about three-quarters—of coking coal (*charbon gras*). An extremely hard metallurgical coke is manufactured, some of which finds its way to Lorraine and to the Nevers metallurgical district. 'A high-quality foundry coke is produced and used locally. About one fifth of the coal is gas coal, and gas is distributed to considerable distances, most, however, being used locally. A certain amount of coal goes to supplement the hydro-electric supplies of the St. Etienne district when the water fails in a very dry season.' Most of the coal is consumed in the departments of Loire and Rhône, and practically all of it within the Lyons economic area. About one-fifth goes to feed the railways. Of the coke rather more goes to Lorraine than is used locally, and small quantities are exported to Italy and Switzerland.

By the Gier valley, through which run road, railway, and a shallow canal, St. Etienne is in close touch with Lyons. The whole region is industrialized and the canal, now derelict, used to supply the industries with coal. A railway tunnel at Terre-Noire, in the Giers valley, unites the industrial areas on either side of the water-parting. St. Etienne itself specializes in the manufacture of firearms, bicycles and cycle parts, and parts of motor-cars, and has an important textile industry in which ribbons form a major article of manufacture. With this town we shall have to deal again when we come to consider the Lyons region.

ROANNAIS. On leaving the Forez plain, the Loire once more neglects frequented ways, and in a deep and winding gorge cuts its way across a horst of crystalline rocks which separates Forez from the basin of Roanne, descending abruptly to a lower level by the Saut de Pinay and the Saut du Perron. The two basins of Forez and Roanne are very similar in structure and development, though the size of the Roanne basin is double that of the Forez. The average level of the floor of the lower basin is only slightly lower than that of the upper one, but the actual level of the valley in the lower basin is far below the level of the old lake floor, for the Loire trenches deeply. The south-western

¹ See Figs. 15 and 55.

edge of Roannais is formed by the granite Monts de la Madeleine, which are heavily wooded. The eastern side is composed of

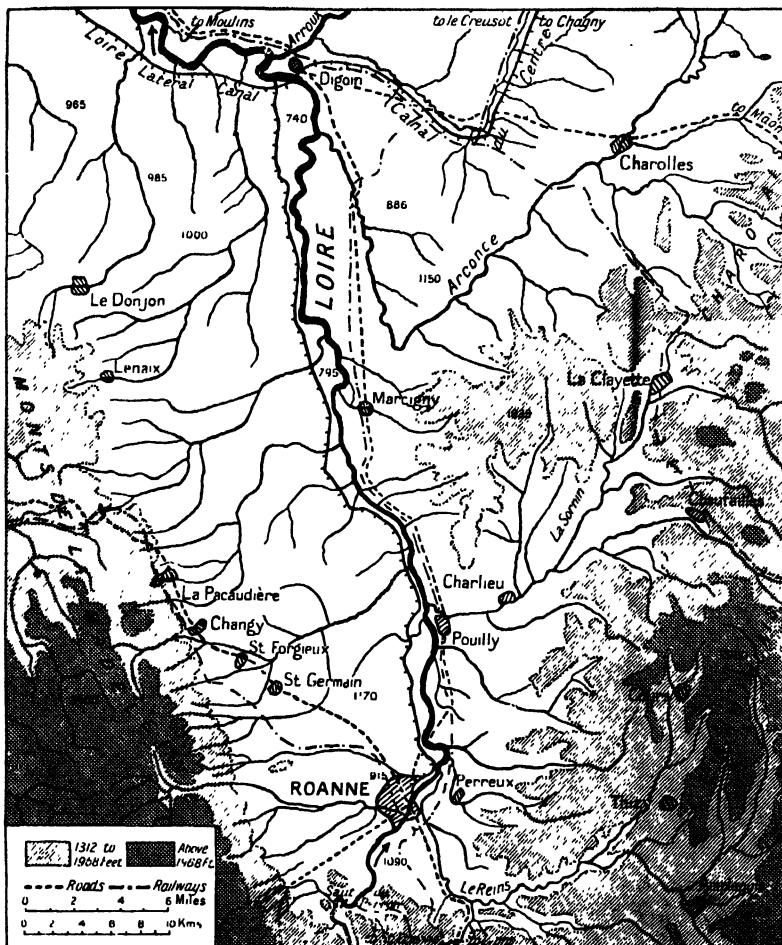


FIG. 16. THE ROANNAIS. NOTE THE CONTRAST BETWEEN THE ABRUPT WESTERN EDGE OF THE BASIN, FORMED BY THE GRANITIC ROCKS OF THE MADELEINE, AND THE MORE DISSECTED BROKEN COUNTRY TO THE NORTH-EAST, WHERE SEDIMENTARY ROCKS ARE EXPOSED. THE MAP SHOWS THE INDUSTRIAL VALLEYS TO NORTH AND SOUTH OF THE BASIN, CONTRASTING WITH THE SPARSELY PEOPLED VALLEY FLOOR BETWEEN. CF. FIG. 14.

Jurassic limestone, which represents the preservation, owing to faulting, of those sedimentary rocks which once covered the dome of Charollais and Mâconnais. The effect on the drainage

of this difference in rock-formation in the two sides of the basin is shown on Fig. 16.

Roanne, a town of 40,447 inhabitants in 1936, is one of the few centres of the Massif that has grown rapidly in recent years. In 1880 it had a population of only 19,350 persons. It owed its importance in earlier times to the fact that it lies on the Loire, at the head of such navigation as there was (now improved by a lateral canal), at an important crossing-place. This point of vantage made it a collecting centre for goods from Lyons and the Midi, and from the St. Etienne coal-field for Paris or Nantes. It has developed a noteworthy manufacture of cotton-spinning and weaving, producing a great variety of coloured goods, dyed in the yarn, though, like all the cotton manufactures of southern and central France it has suffered severely from the competition of the textile region of the north and north-east, based on more important coal-fields. It makes cottons, woollens, and muslins, and mixtures of cotton and silk, especially ribbons, for the Lyons market and specializes in knitted fabrics.

Amplepuis, Tarare, and Thizy are cotton textile towns in the upland between Roanne and Lyons. They manufacture both cotton and silk and mixtures, e.g. velvet and plush. Tarare used to be noted for its fine muslins, but there is little demand for these to-day and the population has diminished by several thousands in the last forty years.

The agricultural basin to the north of Roanne is but sparsely inhabited, but a string of large villages of about 500 inhabitants follows the railway in the direction of Moulins, avoiding the flood-plain of the Loire. The northern end of the basin is forked. A long trench, some six miles wide, unites the Saône basin at Beaune with the Roanne depression, and separates the Autunois from the Monts du Charollais. Its marshy, lake-strewn floor is drained south-west by the Bourbince and north-east by the Dheune. Along its northern edge lies the coal-field of Blanzky-le-Creusot. The relatively soft rocks of the Hercynian syncline in which the coal-measures have been preserved have been worn out to form this passage-way which links the Rhône valley and the Loire valley industrial areas. The passage-way is followed by two parallel roads, a railway, and the Canal du Centre. It is dotted with a number of mining towns and villages, of which the Blanzky and Montceau-les-Mines group have the most productive mines; and, just to the north of the low-water parting that separates the Loire and Saône drainage lies the great arsenal of Le Creusot at a height of 1,138 feet. With a population of 29,392, it is comparable in size with its neighbour in the Saône valley, Chalon-sur-Saône, but not nearly as large as Roanne. It

is expanding along the road to Montceau-les-Mines on the one hand and Couches-les-Mines on the other. The great Schneider works lie to the north and east of the town. The output of coal in the basin of Blanzy-le Creusot is about 2,200,000 tons. It is raised in the mines of Blanzy and Montceau-les-Mines, in a district numbering 23,000 persons, which lies on the Canal du Centre. The iron and steel industry of Le Creusot was founded on iron deposits, now worked out, in the neighbourhood of Nolay.¹

The north of the basin of Roanne is shut in by Autunois, a granite mass lying between the two coal-depressions of Le Creusot and Epinac, and drained by the river Arroux, which collects its numerous head-waters in the impervious granite and schist and brings them down to join the Bourbince just above the confluence of that stream with the Loire.

Autun, 1,000 feet above sea-level, lies on a mound in a rectangle almost surrounded by the Arroux and its tributaries. It arose as a Roman station and stronghold (*Agustodunum*), on the route from Chalon-sur-Saône (*Cabillonum*) to Nevers (*Noviodunum*). The walls of the Roman fortress cover the whole summit of the hill, and enclose in the south-east of their circumference the much smaller medieval city. The east to west route via Autun provides a short cut from the Saône to the Loire, avoiding the circumvention of the rugged Morvan, which projects north from the Central Massif into the basin of the Seine. To-day no fewer than eight roads, six of them *routes nationales*, converge on the town.

The small Autun-Epinac coal-field produces oil shales as well as coal, and oil and petrol are distilled locally. The output of coal is small—under 200,000 tons. Most of the coal is consumed in the Rhône valley and by the railways, but small quantities are sent to many parts of southern and central France for special uses. No coke is produced. The Canal du Centre is an active distributor of coal from this field, and Montceau-les-Mines was, in 1936, the tenth largest inland port in France, for it handled 1.03 million metric tons of freight.

THE ALLIER AND THE AUVERGNE HIGHLANDS AND BASINS

The Allier rises in the Cévennes, twenty miles or so farther south than the Loire, in the south side of the Forêt de Mercoire, at a height approaching 5,000 feet above sea-level. Eight miles to the south, the Col de Trives crosses the water-parting between the Lot and Ardèche head-waters. At La Bastide, on the divide between the Atlantic and the Mediterranean drainage, the railway from Bordeaux to Nîmes and the rail and high-road from Clermont-Ferrand cross the Cévennes. The Allier directs

¹ See also p. 445.

its course northwards in a winding, deep-sunk valley, accompanied by the railway. It forms the boundary between the departments of Ardèche and Lozère. At Luc there is a dam across the river, which holds up the water for a power station.¹ The V-shaped type of valley cut by the river in the granite rocks is not very well adapted for road-construction, and at Langogne the high-road leaves the Allier and crosses the water-parting to Pradelles in the Loire basin. The Allier trends away north-west, parallel to the bare flat-topped ridges of the Margeride. The long, barren spurs of this upland, running down to the Allier valley, are devoid of population and are given over to the pastur-

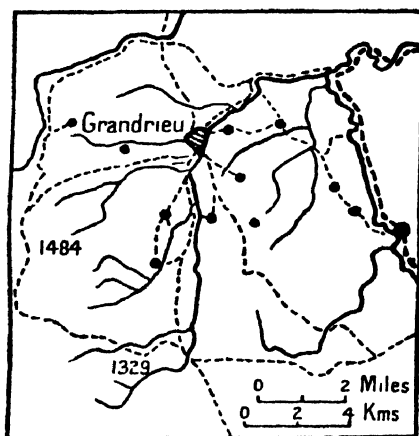


FIG. 17. A TYPICAL CATCHMENT BASIN IN THE HIGH MOORS, SHOWING TRACKS AND FARMS AVOIDING THE VALLEY BOTTOMS

ing of scattered herds of sheep and cattle. The farms in the valleys that descend to the Allier are few and poor; on the shorter, western slopes, falling to the fertile valley of the Truyère, villages are more frequent, farms are more evenly distributed, and cultivation is general. The railway from Nîmes and Bordeaux follows the Allier as closely as the vagaries of the stream permit, crossing and re-crossing the river by magnificent bridges and viaducts, tunnelling again and again through the rocky bluffs that the river has carved in its windings. But no town nor even village of importance save Langeac with 3,750 inhabitants is to be found along its track. The accompanying sketch

¹ For the development of water-power in the Cévennes, see chapter on Industry, p. 440.

shows the type of settlement in the high crystalline part of the plateau. A road winds round the rim of a shallow basin, avoiding the marshy bottoms, and another may follow the main stream. From these roads tracks of from half a mile to three miles long lead to the homesteads which lie on the higher ground of the basin between the streams. There is much enclosed pasture-land on the plateau, on which the dark-red Salers cattle are fed. A little below Langeac the basin of Paulhaguet opens out and villages succeed each other along the valley bottom and on the plateau along the *route nationale* from Le Puy, which here approaches the valley to within three or four miles. The road takes advantage of a *col* between the Monts du Velay and the Montagnes de la Margeride, and, passing by Paulhaguet, cuts across the plateau to Brioude. The Allier flows in a devious course, first in a wide valley through the lower plateau north of Langeac, and then, trenching the higher plateau across a granite horst, descends to Brioude. This town lies at the southern extremity of a tectonic basin about six miles long and two and a half miles wide. It is the first of a series of basins once occupied by Tertiary lakes, through which the river continues to thread its course until its exit from the Massif. Brioude lies away from the river, which is crossed by the high-road in the plateau at Vieille Brioude. The modern town developed on the railway, which skirts the western edge of the plateau. It is the centre for a considerable village industry of *passementerie*, or bead embroidery-making, which extends also to Brassac and Issoire, and gives a valuable article of export.

The floor of the basin descends in terraces from the railway to the river, which hugs the steep eastern edge of the basin where the plateau drops abruptly about 600 feet. The lower plateau, between the *montagne* and the edge of the basin, is dotted with hamlets and small patches of cultivation, but the steep valley slopes are wooded. The walnut wood of this district is noted and furniture-making is carried on at Brioude.

The railway quits the road again at Brioude and enters the busy little coal-mining district of Brassac-les-Mines and Ste. Florine. A number of blast-furnaces are grouped upon the coal-field in the valley of the Allier and in that of the tributary Alagnon, which joins the Allier near St. Germain Lembron. The output is small, about 300,000 tons per annum. River and rail now pass through a gorge below Jumeaux, in which the Allier receives the Alagnon river from the Cantal.

{ *The Cantal*, a great conical mass, some thirty miles across, lies in the same latitude as the basin of Le Puy. It is the remnant of a gigantic volcano which, in its prime, would have made

Mount Etna seem insignificant. The ruins of its vast crater rise in a rim of mountain-peaks, of which the Plomb du Cantal¹ is the highest. The volcano has not only suffered tremendous erosion, but its form has been rejuvenated by glaciation—its crater filled with glacial detritus and its valley system renewed. Great glaciers, starting from the snow-fields that filled and crowned its crater, crept down its flanks, leaving, after the disappearance of the ice, a score of deeply-incised valleys to carry the water that falls upon it to the Loire and Gironde. Villages lie dotted to a height of 4,000 feet upon the slopes of the wide plateau that surrounds the high summit, owing to the fertility of the volcanic soil. The *planèze*, or plateau, of Salers lies to the west of the Cantal. The Planèze proper slopes east to the Allier valley; the Cézalier lies to the north. The lower Planèze is a great wheat land, but the Salers plateau and the Cézalier, being more exposed to the Atlantic winds, are pastoral. Cattle-rearing and beef-raising were the main occupations of the farmers, but there is a tendency to-day towards a change-over to dairy-farming for milk-production. Salers, Cézens, and Aubrac are centres of the trade in the Haute Planèze, at heights between 3,000 and 4,000 feet. Where the streams bring down the manure from the *vacheries* of the high pastures excellent hay-crops are obtained. Road and railway cross the Planèze between Murat and Aurillac at a height of 4,900 feet, both tunnelling through the divide between the Alagnon and the Cère, formed by the western slopes of the Plomb du Cantal. The Planèze de St. Flour, to the south-east of the railway, is covered with a great sheet of basalt, which originated in a succession of eruptions in the Cantal. It is, to a large extent, especially in the lower part, under the plough, owing to the fertility of the soil, and forms a strong contrast to the crystalline and glaciated regions farther west. Its chief crops are rye and wheat. There is a tendency throughout the Haute Planèze for pastoral industries to oust agriculture, however, and hay is now the most cherished crop; but *La Basse Planèze* still remains faithful to the plough. The higher parts are greatly exposed. There are few trees on account of the dryness of the eastern slopes of the Cantal, which often, however, has three feet of snow in winter. Travelling is then by sledge. The snow generally lies from November to April. Winds are violent at all seasons, the north-west winds being cold and dry, while storms come with the south-westerly winds. East winds are rare; hence we find the villages generally facing east. In summer it is often very hot and thunder-storms are frequent. Transhumance is generally practised. With the approach of

¹ Height 6,126 feet.

winter, in November, the cattle return from the *montagne*,¹ or high pastures, which are usually the property of the Planèze farmers, and where, during the summer months, the cheese is made. There are about 260,000 head of cattle in the department of Cantal, more than one per unit of population. Cantal and St. Nectaire cheeses are well known in the lowland markets.

The Alagnon, on leaving the *Planèze*, skirts the Massif of Le Louguet, from whose flanks it draws many tributaries, and is accompanied, at the cost of many viaducts, by the railway from Aurillac, which utilizes its valley until it approaches the Brioude basin at Lempdes.

THE LIMAGNE. To return to the Allier valley. Below the coal-field of Brassac and Frugères-des-Mines another five miles of gorge brings the Allier to the small basin of Issoire, beyond which a ridge of granite has to be traversed before the plain of the *Limagne* is reached. The river enters this Tertiary basin at Vic le Comte. The floor of the *Limagne* lies at about 1,150 feet above sea-level. On the west the ground rises abruptly to a terrace at about 1,300 feet. From this there is a gentle rise to a plateau above the 3,300 feet line. Upon this high platform stand the mountains of the *Chaîne des Puys*. The view from the foot of the Puy de Dome above Volvic of the prosperous *Limagne*, 'level as a lake', and of the fertile terrace overlooking it, is very impressive, as is the great volcanic mound itself, rising steeply from its platform of lava. The volcanic quarries of Volvic have been mined from the twelfth century, and their famous building-stones have travelled far and wide. The lava is used also in the chemical industry, being peculiarly resistant to acid. About 30,000 tons are exported annually.² The cathedral of Clermont-Ferrand is an example of the striking, if somewhat gloomy, effect of the use of this hard, dark, greyish-brown stone. Riom, perched on a spur projecting from the lava plateau, with its complete circle of raised boulevards, is also entirely constructed of lava from Volvic.

The southern *Limagne*, as the ancient lake-bottom is termed, stretches first in a narrow belt from Vieille Brioude, to just north of Issoire (Vic le Comte). Here the granite uplands of Livradois, which have formed the eastern walls of the basin, come to an end and the *Limagne* opens out to a width of from eighteen to twenty miles, to include the basin of both the Allier and the Dore. Livradois stands in marked contrast to the volcanic plateau which bounds the plain to the west. The impermeable upland, rising everywhere to a height of over

¹ The local term *montagne* does not mean 'mountain' but 'pasture'.

² See *Inventaire de la Production Française*, 1923.

3,600 feet, has the sluggish, indefinite drainage, accompanied by bog and peat moor that is typical of all the higher crystalline parts of the Massif. As elsewhere, the higher part of the plateau is flanked by a plateau at a lower level, to which the streams descend as torrents and in which they speedily entrench themselves. Owing to difficulties of communication, families have to be self-sufficing, which has meant cultivation of poor ground at the expense of pasture and forest, though the latter has persisted over large tracts in the more elevated southern portion of the plateau. Latterly cattle have been replacing sheep as a more scientific and intensive farming has made possible the cultivation of fodder for the winter. There is but little rearing of beasts for slaughter, except young calves, which are exported at the age of ten weeks or so. Butter is the main product for the market, and the cows do the draught-work, ending their career of usefulness, when they are too old for work, by being fattened for the butcher. Thus, with improved farming the area under crop has diminished and the forest, partly under afforestation and partly naturally, is increasing. As in other parts of the plateau, the cottage textile industries of the upland, based originally on local-grown wool, hemp, and flax, and later developing cotton-spinning and silk-spinning and weaving, have decreased owing to the emigration of the inhabitants to the works established in the valleys.

The impermeable nature of the rocks, causing a rapid run-off, and the absence of large lakes, often mean a total desiccation of the streams in the summer and preclude the establishment of cheap hydro-electric power, while the district is too far removed from the Rhône valley to benefit, like the eastern part of the Massif, from the hydro-electric installations there. While afforestation is increasing, the number of charcoal-burners and sawyers has fallen. The latter have always made seasonal migrations to more accessible forest regions, but now the migrations tend more and more to be permanent. Silver-zinc used to be mined in this neighbourhood, but, like the other industries, the mining has declined.

The Dore, which separates the Monts du Forez from Livradois, also passes through a small Tertiary basin with the centres of Arlanc, Marsac, and Ambert. The people are employed in dairy-farming, especially for cheese, and in ribbon- and lace-making for Paris houses, which is a subsidiary occupation common in districts of poor farming. This is specially developed in Ambert and the neighbourhood, and the latter town has a flourishing industry in the making of *articles de piété*, for both Christian and Mussulman. This originated in the turning

of wooden beads for chaplets, a not uncommon industry of the wooded uplands. A railway from Le Puy to Moulins uses the corridor of the Dore. At Ambert the river drops to the lower plateau at an altitude of about 2,300 feet, where agriculture prospers and the population is relatively dense. In the Olliergues district the weaving of hemp and flax still goes on. The rapid streams that descend from the edge of the low plateau to the Dore were used early by the villagers of the valleys in the development of a cutlery industry. The most important of these is the Durolle, which supplied the power for the industry of Thiers in the Middle Ages and continues to do so, although electric motors have succeeded the water-wheels. St. Rémy is also engaged in the industry. Near Courpière the river enters the Limagne.

The contrast between the lower plateau at 2,300 feet or thereabouts and the floor of the basin, with an average level of about 1,300 feet, is marked. The plateau is covered with small hamlets and farms, with here and there a small textile factory. The plain has a population equally evenly distributed, but very much denser: large villages, rarely more than a mile or a mile and a half away from one another, take the place of farms and hamlets. The Limagne of Clermont-Ferrand is reputed to be one of the most fertile parts of France. In the south the lacustrine marls and limestones are frequently intruded by basaltic dikes, and many limestone hills are capped with basalt. Villages and castles crown these heights, while the lowland between the hill-slopes is irrigated and intensely cultivated. Wheat and sugar beet are important crops on the plain, while the vine occupies the rising ground. Market gardens and orchards surround the towns of Clermont, Royat and Riom, and provide the raw material for preserving industries. The Limagne proper continues northward, with Gannat as its centre. The Allier cuts diagonally across it to join the Dore on the extreme eastern granitic edge of the basin, about nine miles south of Vichy. The floor of the Limagne is corrugated by the streams, which cross it now from one side, now from the other.

(Clermont-Ferrand, with its suburb of Royat, had a population of 92,500 in 1936 and is the centre, not only of the fertile plain but of a great part of the Massif, although, owing to the centrifugal trend of the natural lines of the region, no one town has been able to dominate the region entirely.¹ Clermont-Ferrand owes its position and growth in the first place probably to the crossing of the two ancient highways Paris-Nîmes and Lyons-La Rochelle, and secondly to the relatively great fertility of the Limagne. Leroux² does not mention the town among the principal

¹ Leroux: *Central Massif*, Vol. II, p. 12.

² Leroux: *op. cit.*

industrial centres of the Massif. Its name only appeared late (eighteenth century) in the list of woollen manufacturing centres of the region. Colbert introduced stocking-knitting among the women of Auvergne, especially in Clermont. In the eighteenth century an attempt was made to establish a silk industry there. Curiously enough, Clermont has never been able to draw to itself the industries of neighbouring townlets, such as Riom and Thiers, which still carry on their ancient occupations, and it is only with the evolution of the motor-car that Clermont has counted as an industrial centre of importance. Thiers used to be the principal centre for hardware in Auvergne, and exported to Spain and India. To-day, as a result of the local coal and improved communications, Clermont-Ferrand has developed its early industry of rubber manufacture, for the raw material is not costly to transport. Great tyre-works now stretch between Clermont and Mont Ferrand. In Clermont alone about 15,000 men are employed in the industry. Other chemical industries have developed here, especially the making of sulphuric acid. Clermont possesses also large mechanical engineering works and makes hydraulic installations, railway and mining material. There are also bronze foundries. Textiles are represented here by hosiery, veiling, etc., and clothing factories are important. When we consider this industrial development, and that of the mineral water spa of Royat, in the southern suburb, together with the establishment of the great military aerodrome of Aulnat, a couple of miles to the east, we are not surprised to find that Clermont-Ferrand is one of the three larger centres of the Massif that has increased its population since 1891. The small coal-fields of the department of Puy de Dôme produce about 750,000 tons of coal per annum. Yet, in spite of this industrial activity, and although there are other centres, Clermont is still primarily the chief market for the agricultural and market-gardening produce of the fertile Tertiary plain, so rich in lime and phosphates, and its ancient fruit-preserving industry (*confiserie*) utilizes the orchard products of the district. The fruit confections are exported in large quantities, particularly to England. In addition, the town is the hide and leather market for the departments of Cantal and Allier.

As we move north, following the Allier, villages continue to swarm over the surface of the plain, except in one or two areas where an accumulation of sandy alluvium has dedicated the land to forest. Vichy, in a bend of the Allier, at the foot of a spur of the Madeleine, was in 1881 a small watering-place of 6,000 inhabitants which received some 28,000 visitors during the year mostly invalids, to drink the alkaline waters from the eight

springs of which the Célestine is perhaps the best known. Since then its population has nearly quadrupled. The bottling and export of mineral waters from the various springs and the manufacture of Vichy pastilles occupies a large number of the inhabitants. The bottles are made in Montluçon. A little to the north of Vichy, at St. Germain des Fossés, where there are important dye-works, the crystalline rocks of the Forez edge give back. Here the railway line from Limoges via Montluçon, Gannat, and Roanne passes to Lyons and meets the line from Paris. At this point we enter the *Limagne Bourbonnaise*. The waters of the Sioule now irrigate the vineyards of the plain and Pourçain-sur-Sioule, on the banks of the stream, is noted for its white wine. To the west, behind Ebreuil, the granite plateau with its basalt counterpane and towering *puys* gives way to a lower schist plateau about 1,000 feet high, drained by the Sioule and the Cher, whose basins are separated by the granite hills of *Combrailles*. The Sioule valley, thanks to hydro-electric works, and to the railway, is becoming industrialized. There are electro-metallurgical works at Ancizes; at St. Ours electro-copper is produced. Main road and railway pass across the plateau to Montluçon and Commentry. Shortly before the junction of the Sioule, the Allier begins to braid its channels, flowing in a definite *thalweg*, with low, easily-abraded cliffs of sand and clay. From Varennes-sur-Allier and from St. Pourçain-sur-Sioule two national roads follow the low cliffs on either side of the river to Moulins.

The *Monts du Forez* lie between Le Chambon in the north and St. Anthème in the south, separating the valleys of Loire and Allier. They are typical of archæan highlands and consist of a high plateau at about 4,300 feet with a harsh climate, made more harsh by the cruel winds that sweep across them in the winter and by the long-lying snow. Here are no habitations but the temporary huts of the shepherds, for the windy plateau-top is devoid of trees and is covered with moorland pastures where, in the summer, the cattle find a living among the vast stretches of heather. The peasants clear long strips in the heath called *fumées*, to encourage grass.¹ Apart from the pastures, the only occupation offered by the higher plateau is forestry. The steep slope that leads down to the lower plateau between 3,000 and 2,300 feet is generally wooded. Firs occupy the higher slopes and elms intermingled with limes the lower. Timber is exported by rail from the towns on the edge of the plateau, such as Ambert and Montbrison. Below the wooded slopes the lower plateau lies

¹ E. Lapayre: 'La Vie pastorale dans le Massif du Forez' (*A. de G.*, 1926, p. 300).

like a platform round the higher mass. Here the bulk of the land is cultivated. The flat-bottomed, glaciated valleys lend themselves especially to the cultivation of irrigated pasture. Cereals are grown all over the lower plateau, and in spite of the natural facilities for the production of grassland, the peasants have not turned their ploughland into pasture to the same extent as those of other areas in the plateau—the Cantal, for instance. Sheep are disappearing before the milch cattle, as are also the cattle reared mainly for draught purposes. Ambert cheese, resembling Gorgonzola, is the speciality of the Forez uplands. It is deteriorating in quality, unfortunately, owing to the demand for cream of the neighbouring large towns of Lyons, St. Etienne, etc. The calves are sold to the farmers of the plain for fattening. The women usually accompany the cows and sheep in their annual migration to the highlands, the men, owing to depopulation, being obliged to remain to look after the fields.¹ The summer pasturing lasts from the beginning of June to the end of September. At night and during the great heat of the afternoon the beasts remain in their stables.

With *Moulins* we reach the northern edge of the Central Massif, where the rivers Loire and Allier leave the basins of the Massif to emerge on to the northern plain. The town lies on the right bank of the Allier, at the junction of the railway from Macon. Here the Allier is only twenty miles distant from the Loire at its exit from Roannais. To the west of Moulins lies the Permian basin of Bourbon, bounded on the east by the great coal furrow² which stretches south to the Rouergue district. This basin constitutes the southern end of a great faulted trench, which might almost be described as a 'rift valley', extending northward to the neighbourhood of Clamecy. Opposite to Moulins lies the small coal-field of Fins. Moulins is one of the ring of market towns which surrounds the Massif, acting as collecting and distributing centres for the region, and drawing off a steady flow of its population. The town lies where ancient alluviums rise in low terraces above the present flood-plain to a height of 600 feet. Though a bridge-town of considerable nodality, the place has increased very slowly since 1881. It used to be the seat of the Dukes of Bourbon, probably owing to its strategic position commanding cross-roads running north-south and east-west. To-day it is a small manufacturing town, making agricultural and other machinery, hosiery, clothing, and preparing furs.

The Loire and the Allier flow north-west, parallel to one another

¹ The rural population of the department of Puy de Dôme was 347,000 in 1921 and 302,000 in 1936, a decrease of 45,000.

² See p. 28.

across the plain of *la Sologne Bourbonnaise*, where the Miocene sands do not offer a very good agricultural soil. There is much enclosure of small fields, and the land is chiefly pastoral, which adds to its picturesqueness if not to its prosperity. At St. Pierre le Moutier and Decize respectively the rivers leave the Sologne Bourbonnaise to traverse the faulted trench, mentioned above, which constitutes the Nivernais. In so doing they cross the northern limit of the crystalline Massif to traverse the zone of Jurassic rocks which outcrop upon its flanks. First comes the Lias clay, which stretches across the floor of the trench in a belt some twelve miles wide, and then the Jurassic limestone in a zone about forty-three miles wide, covered to the north of Nevers by Upper Tertiary rocks. Nevers stands on a low bluff overlooking the junction of the Nièvre and the Loire, and owes its position to the bridge across the main river which carries the road to Paris. It is the centre of a minor metallurgical district, which includes Montluçon, Bourges and Le Creusot, and was based originally upon the iron ores of Berry. To-day coal is obtained via Paris and from Le Creusot, and the iron ore comes chiefly from Lorraine. This industrial area is associated with those of St. Etienne and Lyons under the name of *Le Centre*.¹

A little below Nevers the Allier at last joins her sister Loire. The lateral canal, which has followed the Loire from Roanne, crosses the Allier by one of the magnificent aqueducts by which the French carry on the tradition of the daring and beautiful in engineering which they inherit from the Romans. The canal accompanies the united rivers to Briare.

At Cosne the Loire enters the Cretaceous rocks of the Paris basin.

THE CHER, THE CREUSE, AND THE PLATEAUX OF COMBRAILLES AND MARCHE

The Cher collects its head-waters in the Central Massif in the granite plateau of Combrailles lying to the west of the volcanic chain of the Puy. The Collines de Combrailles, with an average height above sea-level of about 2,500 feet, separate the Cher drainage from that of the Allier, while the Cher forms the boundary between the departments of Puy de Dôme and Creuse. The plateau basin of Combrailles sinks gently from 2,500 feet to about 1,150 west of Chambon-sur-Voueize, the average height being something like 1,500 feet. Here the large reservoirs of the Etang des Landes near Chambon and the Etang de Pinaud near Chévrailles supply the colliery district of Aun. The valleys, as

¹ See pp. 437 and 445.

is usual on the lower plateaux, are deeply trenched, and often form very beautiful gorges. In their bottoms, owing to *amendement* and ease of irrigation, are fertile meadows, while on the low plateaux a poor rye cultivation strives to maintain itself on the thankless, wet clays and barren sands. Chambon, at the junction of the Voueize and Tardes, Evaux and Marcillat, on a tributary of the Cher, form four of a long line of large villages and small towns that follow a depression where the more easily-eroded schists and gneisses separate two granite plateaux which extend east to west along the northern front of the Massif. Evaux has hot springs and a thermal establishment to which, and to the Montluçon-Aurillac railway, it owes its relatively large population of 1,327 persons. For the rest, the population of the upper Cher basin, like that of most of the lower plateau of the Massif, is grouped in scattered hamlets of three or four farms or houses. The ridge of granite which lies to the north of the Chambon basin is interrupted by the north-south coal furrow at Commentry. Commentry, Montiricy, and Montmarault on the coal-field are served by a mineral line and the *route nationale*, which links Montluçon with Roanne. The output of the little coal-field is less than half a million tons, but the coal gave the start to the modern development of the metallurgical industry of *Montluçon*. This town has grown rapidly. In 1881 the population was 21,200; in 1936 it had a municipal population of over 40,000. It arose first as a fortress on a bluff overlooking the Cher and guarding the east and west, north and south routes which pass through it. To-day railway lines, as well as roads, cross here. It is probably due, first to its position on an important railway, and second to its borderland site between the Paris basin and the high plateau, where relatively cheap labour can be obtained and where iron ore used to be obtainable, that the metallurgical industry developed here. The tanning industry depends on hides from the uplands, but the recently-developed rubber industry has to import its raw material. Iron once came from the Commentry-St. Eloi coal-field, but the bulk of the iron used is now imported from Lorraine. The town is served by the Canal du Berry. Guns, shells, and iron pipes are manufactured, mechanical engineering is carried on, parts of motor-cars are made, and there are about 1,500 men employed in a motor-tyre works. Chemical works are engaged chiefly in the fabrication of superphosphates. The ancient château lies in the very centre of the town, in a bend of the Cher.

After traversing the archæan rocks of Indre and west Allier, with their steep, vine-clad valley slopes, the Cher enters the depart-

ment that bears its name. The southern part of this department is a depression in the Lias clay, where, at St. Amand, Montrond, and Charenton-sur-Cher, owing to cheap water transport of coal, etc., and an abundant water-supply, a number of industries have sprung up—foundries at St. Amand, porcelain and tile factories, distilleries, etc. This Lias trench is the famous *Vallée Noire* that George Sand made the stage of so many of her charmingly sympathetic, if somewhat idealized pastoral studies. Seen from the crystalline, moor-clad hills to the south, or from the sandy Tertiary heights to the north, this great wooded vale stretches east and west and forms a most striking geographical feature. No longitudinal river utilizes it. It is crossed almost at right-angles by Auron, Cher, Arnon, Indre, and Creuse, though the Canal du Berry takes advantage of it between St. Amand and Sancoins. The effect of dark foliage provided by the hedgerows full of trees that encircle the tiny meadows, in which a white cow or two and a few goats may be seen feeding, the numerous orchards and small woods of oak and chestnut, justify the appellation *noire* when the landscape is viewed from afar. Small streams wind through the vale in divers directions accompanied by reedy water-meadows and small meres. Drove of geese and small flocks of sheep and goats feed on the commons. On the slopes are the more prosperous farms, where the vine provides a money crop over and above the provision of the necessities of life. Here, as in the Massif, the ox is the draught animal, and his slow, steady movements as he draws the plough across the field are symbolic of the quiet, toilsome, patient industry of the peasant of these poorer lands of France. Nohant Viq still boasts the château, which was the home of the authoress, and keeps green her memory.

THE CREUSE. *The Creuse* enters the Loire about thirty miles below Tours. It springs from the plateau of Millevaches, the highest part of the Limousin plateau, a great mass of granite with an average altitude of 2,600 feet that extends southward in a long, flat-topped ridge traversed in deep valleys by the upper waters of the Dordogne and its tributaries. The Creuse has but a short course within this higher plateau, and soon leaves it to cut across the lower northern upland of granite, dividing the plateau de Combrailles on the east from the plateau de la Marche on the west. The river follows the fault of Ahun in the granite, in the downthrow of which has been preserved the little coal-field of that name.¹ The department of Creuse, which consists of the upper basin of that river, lies for the most part within the

¹ L. D. Launay: *Géologie de la France*, pp. 127-9.

old province of La Marche, but also in those of Berry, Bourbonnais, Limousin, and even Poitou. The plateau of Millevaches, with the plateau of Gentioux which lies to the north of it, are spoken of locally as *La Montagne*. They have all the characteristics of the higher granite plateaux of the Massif.¹ *The plateau de la Haute Marche* at an elevation of 1,300 to 1,700 feet resembles the lower plateaux to the east already described.² Its deeper valleys mean better-drained plateaux tops than are provided by the shallow drainage of the moors in *la Montagne*, and make possible irrigated meadows in the valley bottoms during the heat and drought of the summer. *La Montagne* has, of course, a sparse population, everywhere less than thirty persons per square kilometre, for though the summers are hot the winters are very cold and snow lies deep for six or eight weeks. The sole town of note, Aubusson, in the Creuse valley, at 1,400 feet has a population of only 5,340, although it is an industrial centre with a small woollen textile industry and has for centuries been famous for its tapestries and still finds a market for its carpets. Ahun, nine miles downstream, is a large mining village with 690 inhabitants. On the lower plateau, the agricultural market of Guéret which lies at 1,430 feet at the head of a minor tributary of the Creuse, owes its higher population (6,995) to the convergence of roads and railroads crossing the plateau, the most important being the line from Montluçon to Limoges. La Souterraine on the Paris-Limoges-Bordeaux railway has a population of 3,759, and lies at a lower level (1,200 feet). It is an example of an agricultural market on the more productive part of the plateau, while Bourgneuf, where felt hats are made, and Gentioux are examples of the ring of smaller markets that occupy an intermediate position between the *Montagne* and the plateau, and exchange the agricultural products of the latter for the pastoral products of the former and have small industries based on local products. There is remarkably little forest in La Marche, a condition that characterizes the Massif as a whole. This is due partly to the windy heights and partly to the crystalline rocks which are inimical to deep rooting. In recent years a certain amount of plantation of pines, which can resist exposure to strong winds, has gone forward. On the middle slopes beech is planted and, below, oak. The inhabitants of the upper Cher and Creuse basins are almost entirely occupied in pastoral pursuits or agricultural work, the former in the plateaux of Gentioux and Millevaches. Four-fifths of the land is under cultivation and only ten per cent is left waste, which is remarkable when the nature of the land is considered, and compares favourably with

¹ pp. 30 and 31.

² p. 53.

Cornwall or Devon or Sussex. The acid soil, where it has not been limed, produces in the main only the poorer cereals, as rye and buckwheat. Where better facilities for communication with the exterior exist, and especially under the modern conditions of new railway lines and motor haulage, liming has made possible the substitution of wheat and barley for the 'poor man's crops'. Yet, even with *amendement*, the yield of cereals per acre is very low. The adaptable potato, on the other hand, does well in the light, often sandy soil, and is an important article of export to the large centres round the Massif and even as far afield as England. The upper Creuse basin shares with the upper Vienne the supremacy in France for cattle-rearing on the mountain pastures. Beasts are sent down to the plains to be fattened and the young calves to be turned into veal. Sheep are grazed on the *Montagne* in summer and go down to La Marche in winter, or, more frequently, are sold off to the butcher on account of the paucity of winter fodder. The number of sheep is decreasing; there were 1,500 in 1936. The great difficulty, as with cattle, is to provide them with forage in the *Montagne* during the winter.

THE VIENNE AND THE LIMOUSIN PLATEAU

The Vienne also rises in the plateau of Millevaches, giving its name to the department of Haute-Vienne, which embraces the greater part of the ancient province of Limousin to the south of Marche. The upper reaches of the Vienne drain the great rainy plateau which stands first among the natural grazing-grounds of France. The lower plateau, as usual, is not granitic, but formed of archæan gneisses and schists, and is one of the most fertile and densely-peopled parts of the whole upland. Eymoutiers on the Vienne, where it crosses the granite, lies at 1,370 feet; St. Léonard, on the schists, lies at 980 feet. The altitude of the southern part of the plateau of Millevaches (the land of many springs), and its westerly aspect, have endowed it with a more plentiful and more evenly distributed rainfall than is experienced in other parts of the Massif. The mean annual rainfall for the north-western slopes of the plateau everywhere exceeds 39 inches, and, although the spring and autumn maxima are evident, there is no pronounced summer drought, as in the northern basins and on the southern slopes. The July minimum rarely falls below 2.9 inches. Even at Limoges, at a level of only 964 feet, the annual rainfall is 35 inches. This well-distributed rainfall means rich pasture on the high plateaux and luxuriant, well-irrigated meadows in the valleys. Hence the comparatively large number

of horses and cattle recorded for the department of Haute-Vienne.¹ Geese and turkeys are also reared in large numbers. A local cheese is made from goats' milk, and goose and kid-skins are sent to Poitiers to be worked up. On the lower plateau, until recently, cereal culture was tending to replace other farming, but of late the towns have made a greatly increased demand for milk and butter, that it is profitable to supply. Potatoes, rye, wheat, buckwheat, and oats are the main crops, and, with the modern improvement in scientific manuring, sugar beet. The chestnut plantations, which cover a great part of the valley slopes, provide another valuable food crop and emphasize the climatic and cultural link with the Midi. The vine, however, cannot stand the long, harsh winter. Forests, as in the rest of the Massif, are few.

Limoges stands at 964 feet on spurs of the lower plateau, which here rises to about 1,110 feet above sea-level. It had a population in 1936 of 89,724. It was the Roman *Augustoritum*, from *ritos* meaning a ford; but it is difficult to see where, in the deeply-trenched valley, the ford could have been. Of Roman remains there are few extant. But the place must have been an important Gallic centre that sent 10,000 fighting men to the help of Vercingetorix at Alesia. Like those of all the rivers of the Western Massif, the valley of the Vienne is steep-sided and narrow. It was not until the last century that it became a thoroughfare, and it was not on account of any easy way afforded by the Vienne valley that Limoges became a route centre. It was as a crossing place for plateau routes that the site acquired significance. The ancient city of Limoges, like London, stood surmounted by its cathedral, on the steep bluff overhanging a curve of the river. To-day there are five bridges over the Vienne, one carrying the railway from Toulouse. Limoges is the point of exchange that unites the interests of the whole of the western plateau and of Limousin in particular with the basin of Aquitaine and its outlets of Poitiers and Toulouse.

Owing partly to the relative fertility of the plateau of Limousin and partly to the nodality of its position, Limoges early became an entrepôt. Its fame in the world of art dates back, some say, to Gallo-Roman times. There is a tradition that its famous enamel industry was established by St. Eloi. Others attribute

¹ The numbers of livestock in the department of Haute-Vienne in 1937 were as follows :

Cattle	.	.	.	.	277,790
Sheep	.	.	.	.	183,760
Pigs	.	.	.	.	182,270
Horses	.	.	.	.	5,060

its foundation to the Venetian trading colonies which existed there from the eleventh to the fourteenth centuries. It has been suggested that it was its artistic renown that drew the Arab invaders there. In 846 the city was raided and destroyed by the Normans, and throughout the Middle Ages it had a stormy career, during which siege and ravaging alternated with periods of sunny prosperity when Limoges traded vigorously with the foreigner. The town was attached by turns to Aquitaine, to Brittany, and to France, which is not surprising when we note its geographical position, which enables it to turn its face in all three directions. Its facility for facing now one way and now another, to which it yielded in 1370 brought upon it a murderous punishment at the hands of the Black Prince. In the fifteenth century Limoges was trading as far afield as England and Germany, and in the seventeenth century was still in close touch with Hamburg, Amsterdam, and Lisbon. The development of canals and later of railways detracted from the importance of Limoges as an entrepôt, by making direct communication more easy; but the railways gave, in exchange for this lost trade, the possibility of manufacture, and export of goods manufactured. Coal can be easily imported from the small coal-field of Ahun and from England. Kaolin comes from the granitic district of St. Iryieux. A number of mills, employing some 33,000 hands, spread along the river Vienne, prepare, with the aid of water-wheels, the clay which is worked up in about thirty-four factories in and about the town. At first, the Limoges china went chiefly to America. Later the town catered for a Mediterranean and eastern market. Latterly the industry has been feeling acutely the competition of the china and pottery production on the coal-fields of Flanders. Limoges had an earlier industry which was famous throughout western Europe—the manufacture of woollens, based on the sheep of *La Montagne*, and the clear moorland water and the rapid streams that turned her water-mills.

(Owing to parallel lines of faulting, the plateau of Limousin, after rising gently towards the south, ends abruptly above the Permian basin of Brive through which the descent is continued steeply in a series of giant steps to the lowlands of Guyenne.) Round the basin of Brive lie a series of small coal-fields.¹ Arthur Young writes of the 'immense view from the descent to Donzenac'.² 'The country is all hill or valley; the hills are very high and would be called with us mountains, if waste and covered with heath; but being cultivated to the very tops, their magnitude is lessened to the eye. Their forms are various; they swell

¹ Compare the Pilsen Basin in Czechoslovakia.

² Arthur Young: *Travels in France in 1787-9*, p. 35.

in beautiful semi-globes ; they project in abrupt masses, which enclose deep glens ; they expand into amphitheatres of cultivation that rise in gradation to the eye ; in some places tossed into a thousand inequalities of surfaces ; in others the eye reposes upon scenes of the softest verdure. Add to this the rich robe with which nature's bounteous hand has dressed the slopes, with hanging woods of chestnut.' The steep descent is drained by the Dordogne and its tributaries the Vézère, the Isle, and the Dronne, flowing to the Gironde. The last two have but a short stretch of the Jurassic limestone to traverse before they enter the secondary rocks of the basin of Aquitaine. The Vézère and its tributary the Corrèze drain the Permian *basin of Brive*. The latter stream gives its name to the department of Corrèze, of which Brive is the sub-prefecture. Six national roads and six railway lines converge on this little town, which, seen from above, has a delightful position, recognized in the nickname 'Brive-la-Gaillarde'. It was built on a former bend of the Corrèze, which has now been straightened and, like all the towns of the Massif, has narrow streets radiating from the church in the centre, and an inner ring of boulevards representing the old ramparts. Tulle, eighteen miles upstream, on the Corrèze, and standing at 300 feet above sea-level is a very different and much more picturesque little town of 13,969 inhabitants. Its houses hug the river banks on both sides at the bottom of the deep valley. Its population of lace-makers has dwindled in the last thirty years, just as that of Brive has gained. Tulle gave its name to the fine nets that were so much in vogue in the last century. Its rushing stream turns a number of mills and made possible the manufacture of small arms that gave it a certain importance.

South of Bas Limousin and the basin of Brive lie the great Jurassic plateaux known as the Causses of Martel, Grammat, Quercy, and Limogne. Between the Hercynian masses of the Central Massif and of the ancient foundation of the Pyrenees, deposits of limestone of immense depth were laid down, during the earlier part of the Jurassic period, under an incursion of the Atlantic. This Limestone floor emerged completely at the end of the Portlandian period of the Jurassic, and during the lower Cretaceous period the greater part of Guyenne was also added to the continent of the Massif. In upper Cretaceous times, however, the sea covered almost all the basin of Aquitaine except the *Causses*, which remained high and dry.

THE UPPER BASINS OF THE DORDOGNE, LOT, AND TARN, AND THE CAUSSES

The Dordogne, rising in the north of the Cantal, reaches the Causses after a varied course across volcanic, granitic, and schistose rocks. Leaving the crystalline area, it enters the Lias clays where they widen into a belt some twelve miles broad. This Lias Clay strip is a more or less continuous feature accompanying the edge of the crystalline rocks from Civray in Poitou through Montbron in Angoumois, Saint Pardoux, Thiviers, and Excideuil in Périgord, Terrasson in Brive, Saint Denis, Padirac, Martel Figeac, and Capdenac in Grammat, where the line turns south along the Rouergue plateau to Lexos on the Aveyron. Its features differ but slightly from those of the Vallée Noire, of which mention was made on p. 57. Most of the rivers cross it and are not at all, or only slightly, diverted from their courses by it. It is, however, utilized frequently by railways, as in the strip between Périgord and Limousin, where it is followed for a stretch of over twenty-four miles. In the Lias, the Dordogne receives the Cère from the Cantal. This river sweeps to the south of the little Tertiary upland basin of Aurillac, which, although at a height of about 2,300 feet, is crowded with farms and hamlets. The railway which comes from Clermont-Ferrand and crosses the centre of the Cantal to descend the Cère valley has undoubtedly increased the prosperity of Aurillac and the district. The town, with a population of 17,130, lies along the valley of the Jordanne, just above its junction with the Cère, at a height of 2,000 feet. The old château stands on a bluff overlooking the town, which has developed, not on the plateau but along the valley, in touch with the bridge. After crossing the granitic ridges that stretch some fifty miles south from the plateau of Millevaches, the Cère drops down into the Lias trench, in which it joins the Dordogne.

At Martel the Dordogne enters the great series of *Causses*, or limestone plateaux, which stretch from the Vézère in the north to the Aveyron in the south. The Dordogne drains the smallest and most northerly of these, which is called after the little town of Martel, lying at the junction of the Lias and the Jurassic limestone, about 1,000 feet above sea-level. The Causses drop steeply to the west. Martel on the southern edge lies at 740 feet, Souillac, in the centre, at 340 feet only. This small town rejoices in the advantage of electric power supplied by waters of the upper Dordogne. The Dordogne, as one would expect, trenches deep into the plateau. The stony slopes of the valley are terraced for vines; figs, almonds, and mulberry trees flourish, owing to the southerly latitude and to the great rampart of the plateau

of Limousin, which shelters all the western Causses from the north. The warm, porous, dry soil, together with the relatively mild winters, have induced a steppe vegetation which resembles in many features that of Provence.¹ Wheat is the typical crop of the plateau lands. Roots and tobacco are also grown. Truffles, gathered in the woods of beech and oak, form a source of income to the peasantry here as in all the western flanks of the Massif, and are used in the manufacture of the famous *Pâté de Périgord* or *pâté de foie gras*. The truffle is a subterranean fungoid growth which develops on the roots of certain kinds of oak. It is preserved at Cahors and other centres and exported in this form or fresh. Afforestation with 'truffle' oaks has been carried on now for the last half century. The trees are planted in deserted vineyards. The geese are pastured with the sheep on the fine, natural herbage of the plateau, dotted with bushes of juniper, box, and hazel, where the population is scattered somewhat sparsely in small hamlets. The flat valley-bottoms are very fertile and produce hay and maize, for the rainfall on the western-facing slopes of the plateau is comparatively high and irrigation is possible. The large valleys, though in form typical of limestone plateau valleys, being deep and steep-sided, are relatively wide, leaving plenty of space at the foot of the slopes for vine cultivation. The smaller streams, however, entrench themselves in deep, narrow trenches, known as *avens*. Here and there over the surface of the plateau are shallow depressions or *sotches*,² as they are called locally, which correspond to the smaller *poljes* of the Dalmatian karst. These alluvial-floored basins are cultivated, but, apart from them, nearly all the cultivation, and indeed the life of the Causses as a whole, is to be found in the valleys. The contrast between Limousin and the Causses is made more striking by the sudden cessation of the chestnut woods which clothe the valley slopes of all the south-west flowing streams of the archæan rocks, but are only met with here and there in the Causses. Scattered on the plateau are patches of oak wood of stunted growth, with an undergrowth of juniper and blackthorn. The great limestone bluffs, showing the almost horizontal stratification typical of the Causses, add greatly to the picturesqueness of the valley scenery and of the sites of the towns, e.g. Rocamadour and Gramat. The Dordogne is raftable but no longer counts as a navigable river. Much oak timber is rafted down from the higher crystalline plateau for barrel staves, to be used in the wine-producing areas of the Basin of Aquitaine and particularly in the Bordeaux area.

¹ Vide J. Guignebet : ' Le Causse de Martel ' (*A. de G.*, 1924, p. 377).

² Pronounced 'soettes'.

The Lot. The river Lot crosses the *Causses de Quercy* some thirty miles to the south of the Dordogne. These *Causses* are very similar to the *Causses de Martel* in structure and appearance, arid and treeless, but the climate becomes progressively warmer and more Mediterranean in type towards the south, as the vegetation shows. Colonies of typical Mediterranean plants are well established on the southern *Causses*. Here too the slopes of the incised meanders of the valley are under the vine, but the *vin de Cahors* comes from the Tertiary gravelly hills that cover the limestone to the south, in the basin of Aquitaine. Walnut here, as in the Dordogne valley, takes the place of chestnut, except on the wetter slopes. Fig trees flourish in the warm soil, though they are in danger of being cut down by frost. The limestone plateau is usually too dry for the cultivation of maize, even where the temperature is sufficiently high. Cahors, in a bend of the Lot, is surrounded on three sides by the river. The old town occupies the top of the limestone bluff and slopes steeply to the river on the east. The old approach to the town was from the west, on the more gentle slope, where the Pont Valentre was defended by a massive turreted gateway, still extant. The river and the steep rise from the waterside were sufficient defence on the south and east. The red-tiled, shallow-roofed houses of three stories exhibit the architecture of the Midi. Cahors is one of those centres already mentioned which links the Central Massif with the surrounding basins—wheat and wine lands on the one hand, pasture and forest and dairy produce on the other. A land, this, that might be described as 'flowing with milk and honey', but a land that is being sadly deserted by its children. North of Cahors, the population of a group of fourteen cantons has dropped by 40 per cent in the last forty years.¹

South of the Lot valley the land drops away to the basin of the Garonne (Aquitaine), except for a narrow strip of limestone plateau which stretches south between that basin and the Lias trench of Villefranche, on the other side of which rises abruptly the granite steep of the *plateau of Rouergue*.

Let us now turn east and follow the valley of the Lot upstream. We cross the Lias at Capdenac, and very shortly after climb on to the crystalline upland. This is a southward extension of the Central Massif, largely granitic, and is continued southward again by the somewhat lower archæan plateau of Ségalas, by the Monts de Lacaune, by the Espinouse, and finally by the Montagne Noire. This extension of the Central Massif separates the basins of the Rhône and Garonne. Between Ségalas and the plateau of Gévaudan, with its superimposed volcanic Monts d'Aubrac, lie

¹ See Appendix, p. 502.

the *Causse of Rodez*. This Jurassic limestone plateau occupies the middle of a long synclinal basin, an ancient arm of the sea, by which the Atlantic in Carboniferous times communicated with the seas that covered Provence and the Alps. The strait is floored with Permian rocks which emerge from beneath the overlying Jurassic rock in the north of the basin. These rocks are composed of black, bituminous shales, overlain by red shales and sandstones.¹ The Jurassic rocks which fill the depression attain to great thicknesses, the corallian reaching 3,300 feet. To-day the *Causse of Rodez* or *Causse of Comtal* (formerly the territory of

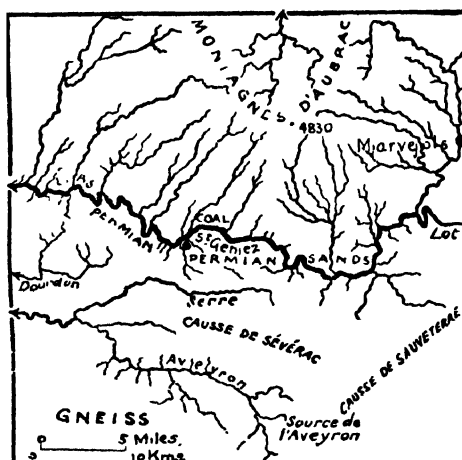


FIG. 18. SHOWS THE MARKED CONTRAST BETWEEN THE HYDROGRAPHY OF THE CAUSSES AND THAT OF THE IMPERMEABLE ROCKS NORTH OF THE LOT. NOTE THE STREAMS RISING ON THE EDGE OF THE BASALTIC PLATEAU OF AUBRAC.

the counts of Rodez) stands bare and treeless at an elevation of some 2,000 feet, overlooked by the higher and more desiccated hill-country of Espalion, whose wooded summits of Permian sandstone, rising to 2,700 feet in the Mont de Roquelaire, stand up in strong contrast to the level, almost treeless, island of the Causse. The Causse of Comtal extends southward and south-westwards, with scarcely a break, into the Liassic limestone plateau of Rodez. The river Lot follows roughly the northern edge of the strait of Rouergue; the Aveyron cuts its deep meanders into the Causse plateau on its southern rim. The ancient fortress

¹ Vide Launay : *Géologie de la France*, p. 165.

of Rodez occupies a site obviously chosen for its strategic value, on a broad, flat-topped spur of the Causse, surrounded on three sides by the Aveyron. The *bastide* commands a fine view northwards over the bare limestone plateau, almost devoid of villages and with but a few small hamlets, and southwards and south-westwards over the crystalline plateau of Rouergue, drained and dissected by the Viaur and its multitude of tributaries, where hamlets lie scattered all over the high spurs between the deep wooded valleys. The position of Rodez was as well chosen for commerce as for defence. Lying as it does between the warm, dry, wheatlands of the Causse and the wetter *bocage* lands or *ségalas*, it was in an excellent position for exchange. It has a population of 14,582. West of the Causse of Rodez and south of the Lot, in the triangle Aubin-Decazeville-Firmi, lies a metallurgical district based on the small coal-field occurring at the intersection of two lines of faulting.¹

Espalion, like Rodez, lies on the edge of the Causse, where the Lot, after an excursion northwards into the gneisses and granites, returns to the areas of Permian rocks, the northern edge of which it follows, with many windings, to La Canourgue. The *Causse of Sévérac*, like the Causse of Comtal, stretches east and west between the Liassic and Permian trenches, which separate it from the crystalline plateaux to the north and south. In this instance the northern crystalline plateau slopes are covered with the basaltic mass that forms the *Montagne d'Aubrac*.

The railway from Brive winds its way painfully up on to the Causse, utilizing the beautiful valley of the Dourdou where it widens above Marcillac. Here, from the walls of the Causse, the water gushes from a series of limestone caverns, creating a little Paradise of freshness and fertility in the midst of the arid uplands.

A fan of streams, rising at about 4,500 feet, drains south from the *Montagne d'Aubrac* and is collected by the Lot. Small hamlets are scattered over the slopes up to a height of 4,000 feet. The river flows in deeply-cut meanders, and there are scarcely any human habitations near its banks except where a group of some 2,500 people live in the little bridge townlet of St. Geniez.) Here coal is mined, for the Lot winds into the strip of Carboniferous rocks.² South of the Lot, for the most part, the *route nationale* runs east and west between La Canourgue and Bozouls, rarely passing a village, while a mile or two farther south, in the strip of Lias Clay, the rivers Serre and Dourdon flow through a broad depression, chiefly meadow land, dotted with villages and hamlets, a contrast to the lonely trench of the Lot. To the south again the bare and dreary Causse de Sévérac rises at a level of

¹ See Fig. 12.

² See Fig. 18.

between 3,000 and 3,300 feet. So abrupt is the slope that on the railway that runs from Marvejols on the north to Millau in the south, the gradient necessitates the assistance of a second locomotive to pull the trains to the plateau-top. Sheep pasture on the treeless herbage and a few shepherds' hamlets are dotted over the lower slopes and in the dry valleys, where a little cultivation is carried on here and there. Sévérac, stands on a bluff overlooking the Aveyron and has a population of 900 persons. It is the wool market for the Causse and collects cheese for the neighbourhood, to be dispatched to Roquefort for ripening.

At the junction of the Urugne, however, where the Lot penetrates into the red Permian sandstones on the edge of the Causse de Sauveterre, the valley takes on more life, and is accompanied by road and railway. The chestnut-wooded sandstone slopes on the north contrast sharply with the craggy limestone cliffs of the south. The lower slopes are vine-clad. The Urugne valley, with its clear waters fed from the *avens* of the Causse, makes a furrow of industry in the lifeless uplands. Woollen textiles, glove-making, flour milling, wood-sawing are all industries which depend for their raw material and power on the agricultural and pastoral life of the Causse, on the forest of the *Rougier*, as the folk call the red sandstone areas, and on the swift waters of the Urugne. Baussac, which lies at the confluence, was one of the centres of the famous red Gaulish pottery industry in Gallo-Roman times (about the first century A.D.), based on the red Permian Clays. Here, as at Espalion and Villecomtal, the red building-stone is almost startling in its vividness.

Above the junction of the Urugne, the Lot has cut, almost to its source, a trench in the narrow belt of Lias Clay, with occasional excursions into the Causse. The flat-bottomed valley lies at about 2,000 feet above sea-level, while to the north the schists and granites rise to over 3,300, and to the south the Causse de Sauveterre to about 2,800. There is room now for railway and national road to follow the Lot. By the Colagne valley from the north the line from Clermont comes in through Marvejols, a little town which lies in the beautiful valley where the crystalline rocks meet the Lias Clay. Here one of the chief industries is the preparation of hides and skins. We are now in the district of Lozère, of which the *chef-lieu* is Mende, capital of the province of Gévaudan. The little isolated *Causse de Mende* lies to the immediate south at about 3,300 feet, and beyond, to the south-east, rises the granite ridge of the Montagne de Lozère to a height of 5,500 feet with all the characteristics of the high crystalline plateaux that we have already noted.¹

¹ See p. 30.

The actual head-waters of the Lot are to be found in a number of streams that rise in the schist Montagne de Goulet, only about six miles from those of the Allier. Between the sources of these two rivers flows the Chassezac, which rises only a couple of miles from the source of the Lot, and which drains to the Ardeche. So that here, just to the north of the Montagne de Lozère, is the divide between rivers flowing to the Loire, the Garonne, and the Rhône. The *route nationale* via the Col de Tribes (3,700 feet) links the upper Lot with the Allier by its tributary the Chassezac. From the moorland summits of Lozère innumerable streams drain north to the Lot and south to the Tarn. The high moors, in spite of their elevation, provide summer pasture for very large numbers of sheep which in winter move south into the valleys and plains of the Mediterranean slopes. The lower hillsides are still to a large extent forested, and only seventy years ago gave shelter to a large number of wolves. Villages are few but hamlets are dotted about on the lower slopes up to about 4,000 feet, at intervals of about two miles. Most of the Mont Lozère, together with the small Massif of the Montagne des Rougs to the south of it drains to the Bay of Biscay, as do the northern slopes of the great crystalline promontory of the Cévennes, which terminates in a granite dome at 4,700 feet to the north-west of Le Vigan. A faulted trench running north and south, in which Liassic rocks have been preserved, is occupied by tributaries of the Lot and Tarn. It divides Mont Lozère and the Cévennes from the great series of Causses tablelands that extend south and south-west from the Lot nearly to the coasts of the Mediterranean. Florac, on the Tarnon, commands the national road that follows this faulted trench. The Col de Montmiral (3,400 feet) connects the Tarn basin with that of the Lot.

The most northerly of the Causses is that of Sauveterre, which is an expanded continuation of the Causse of Sévérac, with an average height of about 3,000 feet. Much of it is wooded, especially in the west, where it is lower. Here there are hamlets dotted over the plateau at intervals of about two miles, but in the more elevated westerly section, which rises to nearly 6,500 feet, it is bare and unpopulated.

THE TARN. The Tarn, which rises in the granitic wooded summit of Mont Lozère at 5,000 feet near the Malpertus, descends 1,300 feet in half a dozen miles; it then enters an open valley in which it receives a number of tributaries. Its valley is wild and deserted, but the slopes of the tributary valleys in the moorland are dotted with farms and hamlets. Near Florac the Tarnon comes in from the Montagne de Aigoual in the south, where, in the forested Cévennes rise the sources of the Hérault and Gardon,

flowing to the Mediterranean, as well as the principal head-waters of the Tarn. The Tarnon follows the fault-line, which separates the crystalline Cévennes from the Causse de Méjean, which, like that of Sauveterre, is bare and dreary and lies about 650 feet higher, but has a lower wooded and more inhabited western section. The Tarn cuts a deep trench separating the two Causses. The valley slopes are steep and often wooded. As the river descends the valley becomes a remarkable gorge, the river winding some 1,400 feet below the level of the plateau. The road from Mende to Millau follows the side of the gorge, but, except at the few crossing-places, it passes through no hamlets or villages. The river continues to zigzag in a generally southward direction. At Peyreleau, where it takes a sharp bend to the west, it receives as tributary the Joute from the east, which divides the *Causse de Méjean* from the more southerly *Causse Noir*. This latter Causse is 330 feet lower on the average, and is separated from the *Causse de Larzac* in the south by the river Dourbie, which flows in a deep ravine across the limestone plateau to join the Tarn at Millau, turning saw-mills which supply local industries. Barrel-staves for the wines of the Midi and sabots are made.

All the important roads in the Causses follow the valleys, until we come to the Causse de Larzac, which is crossed diagonally by national roads cutting at La Cavalerie. The railway from Marvejols comes south from Sévérac across the gneissic plateau west of the Tarn, avoiding the gorges, and only joins the river a little above Millau.

Millau, with a population of 15,884, is *the* market and commercial centre of the Causses. It stands only 1,200 feet above sea-level at the foot of a spur of limestone that drops to a bend in the Tarn where it is joined by the Dourbie. Here the gorge of the Tarn opens as the river emerges from the edges of the plateau. Millau, still more than Cahors, belongs to the Midi. Almond-orchards cover the valley slopes, together with vines and other southern fruits, such as peaches and apricots. It is one of the few towns of the Massif whose population has increased of late years, and is a busy industrial town as well as an agricultural market. Thanks to the oak forests that cover the walls of the Causses, and to the sheep that feed upon its thin pastures, Millau early developed tanning, out of which grew, at a later stage, a glove-making industry. The manufacture of gloves necessitates a special preparation of lambs' and calves' skins, and many skins are imported from abroad. The holm oak is used in tanning the calves' skins, for which Millau is famous, and the bark is imported from the forests of the Cévennes.¹ The skins are exported chiefly

¹ *Vide* Ardouin Dumazet : *Voyage en France*, Vol. XXXV.

to America and England. Thousands of women are occupied in the industry of glove-making, introduced from Grenoble. The old town, with its ancient belfry, lies up the hill—the usual little *bourg*. The modern town has developed on the lower slopes.

The *Causse de Larzac*, south of the Dourbie, lies 330 feet lower than its neighbour, the Causse Noir. It is the most extensive of the Causses. Except for a few hollows, filled with a reddish clay which permits of cultivation, the surface of the Causse de Larzac is grey and stony and the poor scattered hamlets are grey and stony too. La Cavalerie, an ancient *bourg* and old coaching centre, although much decayed owing to the coming of the railway, reaps a certain advantage from the military manoeuvres that take place at the Camp de Larzac every year.¹ In addition it collects the sheep's milk from the surrounding districts for the making of Roquefort cheese, the final stages of whose preparation takes place at Roquefort. The summits of the Causse de Larzac are almost uninhabited except for a few stone shepherds' huts, which are deserted during the winter. Mules are reared on the rich herbage cultivated in the *sotches*, or hollows, of the Causse, which *sotches* also provide the winter forage for the sheep, and here also the sheep find a richer pasture. Sheep-rearers from Bas-Languedoc hire the summer grazing-grounds for small sums, but the manure left by the sheep is disposed of by the owners of the land to the vine-growers of the Midi at a high price, and is sent down by rail.

The Causses were undoubtedly forested at one time. Patches of oak-wood here and there are remnants of extensive woodlands that within historic times were sacrificed to smelt the iron that occurs in pockets in the limestone.

West of the Causse of Larzac, the low slate plateau of Albigeois, drained by the Tarn, separates the granite and gneiss upland of the Montagne Noire from the Rouergue.

The *Montagne Noire* is a peneplaned and re-elevated Massif, resembling in all essentials the archæan plateau of the Central Massif. It is flanked north and south by limestone deposits, which in the north form miniature *Causses*. Owing to fracturing along its edges the Massif drops steeply to the plain of Castres in the basin of the Agout, and to the Thoré valley, presenting a wall-like front, barely notched by the streams that drain to the Thoré. The north-facing slopes are thickly wooded "*toute assombrie par ses forêts, souvent chargée de nuages, elle évoque vraiment l'idée de la montagne*",² and the name must have been fastened upon it by the folk of the northern valleys, from which

¹ cf. Salisbury Plain and the Camp de Châlons.

² André David: *La Montagne Noire*, 1924.

its forested front shuts out the southern sun ; for its southern aspect is quite different. Tilted towards the Midi, it rises gradually on this side in great bare shoulders, with here and there a jutting cliff of grey limestone. Exposed to the glare of the Midi, it carries little vegetation, and its verdure dries to a russet brown in summer. Westwards, the Massif slopes gradually to the foothills of Lauraguais.

The Thoré valley attests a considerable amount of vitality, for the railway from Castres, which is linked with Bordeaux and the Albi coal-field, passes up it to tunnel under the Col de la Fenille into the Orb valley and on to Millau, thence branching to Limoges and Clermont-Ferrand.

Mazamet, where the road from Carcassonne, which crosses the Montagne Noire, zigzags down to the Thoré valley, at the confluence of the Arnette, lies on the edge of a little intermontane basin about three miles long. Here an important industry has grown up—that of the separation of wool from the skeep-skin by a process of fermentation. The local wool is augmented by fleeces from the Argentine and from Australia. The rough wool is sent to Bradford, to the textile area of Roubaix and Tourcoing, to Denmark and Holland, and to the local industries of the Thoré basin. A certain amount of washed wool is also exported.

Castres, where the Thoré valley opens out on to the plain, Mazamet and La Bastide Rouairoux, near the head of the valley, employ about 45,000 spindles and about 1,200 looms in the carded wool industry and the making of felts, flannels, and light woollen fabrics. The original industry was based on local flocks in the upland district round Castres. Mazamet specializes in flannels and felts, La Bastide in men's and women's suitings. Castres makes cloth of carded wool and the upland villages around still make cheap goods of mixed wool and cotton. Mazamet and Castres have iron-foundries, iron and steel and engineering works.

The moor tops of the Montagne Noire, wet and ill-drained in winter, are mere outliers of the *ségalas* of the main Massif to the north. The northern slopes too, with their chestnut forests and the cultivated and well-irrigated valleys that dissect the Tertiary foothills, belong to the *centre* of France. But the southern and western slopes belong to the Midi, with their fruit trees and irrigated vegetable gardens, and their terraced vineyards. So northwards in the Morvan and southwards in the Montagne Noire the Central Massif projects almost isolated masses into the plain, where they stand like the watch-towers at the angles of a fortress. They have the effect of interrupting and breaking into the life and movements of the plain, for, owing to their abruptly faulted edges, they not only form barriers to intercourse, but they

maintain a life with customs and interests largely alien to those of the surrounding lowlands. In the mountain there are no towns and not many villages. On the flanks of the plateau are a number of little markets which carry on exchange between *la montagne* and *la plaine*. The small *bastide* of the upland have not developed beyond their enclosing walls, owing to difficulties of communications, and the towns of the large valleys that surround the Massif like a moat, have grown industrially and commercially at the expense of the medieval centres of the highland.

In following thus the chief rivers of the Central Massif as they diverge like the spokes of a fan north, north-west and west from the Cévennes, we have demonstrated and emphasized the broad characteristics of the Massif as a whole : its impermeable rocks, its streaming waters, its cold and thankless soils ; the summer pastures of the granitic highlands, the scattered farm lands of the lower plateaux of schist.

We have seen that, in spite of these dominant characteristics that justify us in regarding the Massif as a major geographical unit, the region offers great variety of landscape. This is mainly due to the inclusion of sedimentary rocks within and on the flanks of the great archæan mass. Thus we have the parallel coal depressions of the east, and the Causses of the south and west ; the former humming with industry and linked with the outer world, the latter dreary and apart.

We have shown also that soil, aspect, altitude and accessibility have each played an important part in differentiating the various sub-*pays* of the Massif according as they form agents of poverty and isolation or of relative fertility and contact. Finally we have seen that, in spite of the natural physical trend of the region to north and west its most vital contacts are by more or less difficult routes with the east : with the Rhône passage and Lyons.)

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CHAPTER III

THE ARMORICAN MASSIF

THE Armorican Massif is a triangular block of country covering some 18,600 square miles, whose base line forms the western boundary of the Paris basin and whose apex juts out westward into the ocean. The south-west shores of the peninsula are washed by the waters of the Bay of Biscay; its northern coasts face the companion peninsula of Devon and Cornwall across the entrance to the English Channel. Its broad, continental base includes the western sections of Normandy, Maine, Anjou and Vendée. Within the peninsular apex of the triangle lies Brittany, with the Gulf of St. Malo and the Channel Islands.

(M. de Martonne has summarized the geological history of Brittany in the following definition: 'A peninsula recently formed at the expense of an Appalachian type of region in an early stage of differentiation.'¹ The definition holds good for the whole Armorican block. Its present land forms date from the Tertiary period, when a peneplane, resulting from the wearing down of an intensely folded mountain system of the Carboniferous period, was fractured, slightly raised, and tilted, so that a fresh cycle of erosion was started. The hydrographical system that developed on the newly-raised land mass was intimately related to the nature of the rocks exposed by the planing down of the ancient mountain system. The rocks were of very diverse nature and varied from hard, resistant granites, crystalline schists, quartz sandstones, metamorphosed slates to soft clay slates, shales, and clays.

Differential erosion of these varied materials had not proceeded far when, in late Quaternary times, a change in the relative levels of sea and land occurred, which resulted in the formation of the English Channel and in an invasion of the worn-down valleys and coastal areas of the Massif by the sea. Oscillation continued, causing alternate erosion and silting up of the river-beds. Thus the main features of the modern coast-line were formed; though coastal erosion and land building have ever since been the means, slowly but surely, of simplifying the coastal contours.)

This account is, of course, only a very broad generalization

¹ De Martonne: '*La pénéplaine et les côtes bretonnes.*' *A. de G.*, 1906, p. 328.

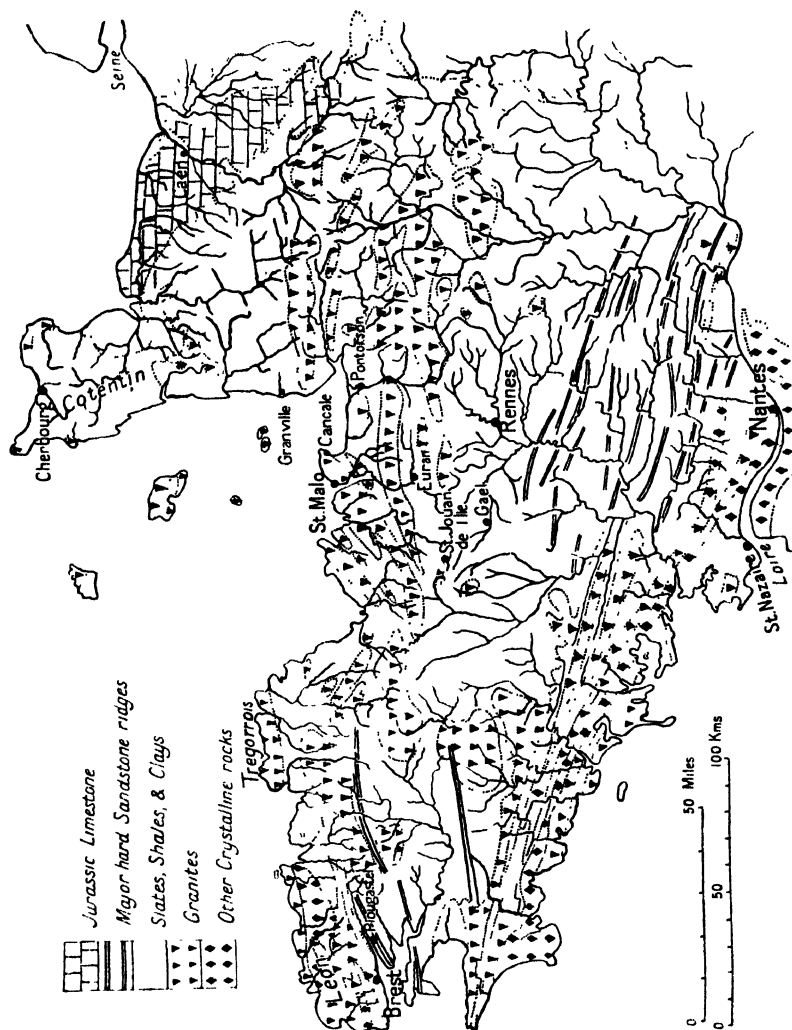


FIG. 19. THE ARMORICAN MASSIF. A GENERALIZED MAP ILLUSTRATING THE INTER-RELATION OF ROCK STRUCTURE, RELIEF AND DRAINAGE. NOTE THE CONTRAST BETWEEN THE STREAM DEVELOPMENT IN THE SOFT ROCKS AND THAT IN THE QUARTZITE SANDSTONES AND GRANITES. THE EXPOSURES OF GRANITES AND SANDSTONES ARE RESPONSIBLE FOR THE PARALLEL RIDGES THAT ARE A CHARACTERISTIC FEATURE OF THE MASSIF.

of what must have been a highly eventful history. There are features of relief that may have their origin in a system of fold mountains much earlier than the Armorican, and there is little doubt that other features of land form and the coast-line area are due, not merely to differential erosion, but also to local tectonic disturbances, chiefly of Tertiary date.

(As a result of the earth movements referred to and also of peneplanation, we get to-day a fairly compact block of land, raised on the average only slightly above sea-level, but with ridges rising to 1,300 feet. Generally speaking, the higher ridges are formed of granite and have gentle, smooth contours. More rugged features are the ridges of extremely hard quartzite that frequently accompany the edges of the granite exposures. Such are the Monts d'Arrée and the Montagne Noire, north and south of the basin of Châteaulin. The schists are usually associated with low plateaux. The slates of all ages form the low land. They are usually easily eroded into clay vales and valleys. Where they comprise the predominant rock they tend to make a broken country in which the rivers flow in wide vales. Where the soft slates appear on the surface as narrow zones hemmed in closely by crystalline rock, they are worn into narrow, elongated valleys between the crystalline heights. The rivers, confined to straight, narrow courses, have only been able to develop short tributaries in the restricted catchment area that separates one slate zone from another.)

Like the Central Massif, the Armorican Massif is bordered, on the land side, by a belt of varied Jurassic and Cretaceous rocks, which embrace it as with a great wall and ditch, the Liassic marls being worn into a deep trench and the Jurassic limestones standing up in a steep-edged, flat-topped plateau.¹

There are two important characteristics common to the whole Massif: impermeability and infertility of the component rocks. These have resulted in a natural rankness of vegetation, in the abandonment of a very large proportion of the land to moor or coppice, and to the prevalence of pasture and enclosed fields. Forests at one time covered the whole of the Massif except where the oceanic winds play on the coast, and tall trees and a thick tangle of undergrowth would soon cover the land if it were left to the care of nature. As it is, the rank vegetation of the hedgebanks, with their rows of pollard trees, that enclose the small fields, give a wooded aspect to the whole country, which is increased by the numerous orchards and small coppices and occasional large stretches of plantation. A wooded aspect, then, is characteristic of the Massif as a whole, and the fact is expressed

¹ Fig. 19

in the term '*bocage*' applied to various sections of the interior. We have the *Bocage* Normand, the *Bocage* Manceau (of Maine), the *Bocage* Breton, the *Bocage* Angevin, and the *Bocage* Vendéen.

Three important geographical facts distinguish the Armorican Massif from the other representatives of the ancient Block Mountains found in France: the Ardennes, the Vosges, and the Central Massif. In the first place, its insignificant altitude for the tremendous pressure of the Alpine foldings have but slightly affected it. The general level of the summits that represent the peneplane hardly rise to more than 650 feet above sea-level. Secondly, there has been no volcanic disturbance. Thirdly, the Armorican Massif is distinguished by its peninsular character. Marine influences play a large part in the climatic conditions, in vegetation and crops, and in the economic development in general.

We may now proceed to a somewhat more detailed account of the various major sections that go to make up the Armorican Massif. We will begin with the most typical of these, the region that has given its name to the whole mass—Brittany, or the Armorican Peninsula proper.¹

BRITTANY

Brittany is a land of ridge and furrow. Its features of relief and drainage, trending for the most part from west to east, are in conformity with the graining of the land, affected by the planing down of the folded rocks. A road journey across the country presents a series of switchback rises and descents that become almost monotonous. To take a typical example:² the road from Vannes to St. Malo, leaving the low platform of crystalline schist, whose drowned valleys form the Morbihan, climbs the granite swell of the Vannetais, and drops from Elven into the deep, narrow trench worn in the band of soft clay slates by the river Arz flowing east and the *Rivière* du Pont du Loc flowing west. It then mounts the three-mile-wide wooded granite ridge of the Landes de Lanvaux, to descend to the deeply-etched vale of the river Claie in the slates. Another granite upland has to be crossed before the interior clay slate basin is reached at Ploërmel and even here the ridge and vale system continues, for the clay slates are frequently traversed by irregular bands of Armorican sandstone, which, a little to the east, in the Forest of Paimpont, form a bold, upstanding mass with steep edges rising to 800 feet, and again south of the Basin of Rennes

¹ Armorica is a Roman name derived from two Celtic words meaning 'sea-side'.

² The student may follow the description by using sheets of the *Carte de France* 1/200,000.

form long, narrow ridges. The road now traverses a basin of Tertiary sands through which the streams have cut down to the clay slates beneath. This gives a broken, undulating country, of which Gaël is the centre. Another ridge of sandstone at St.

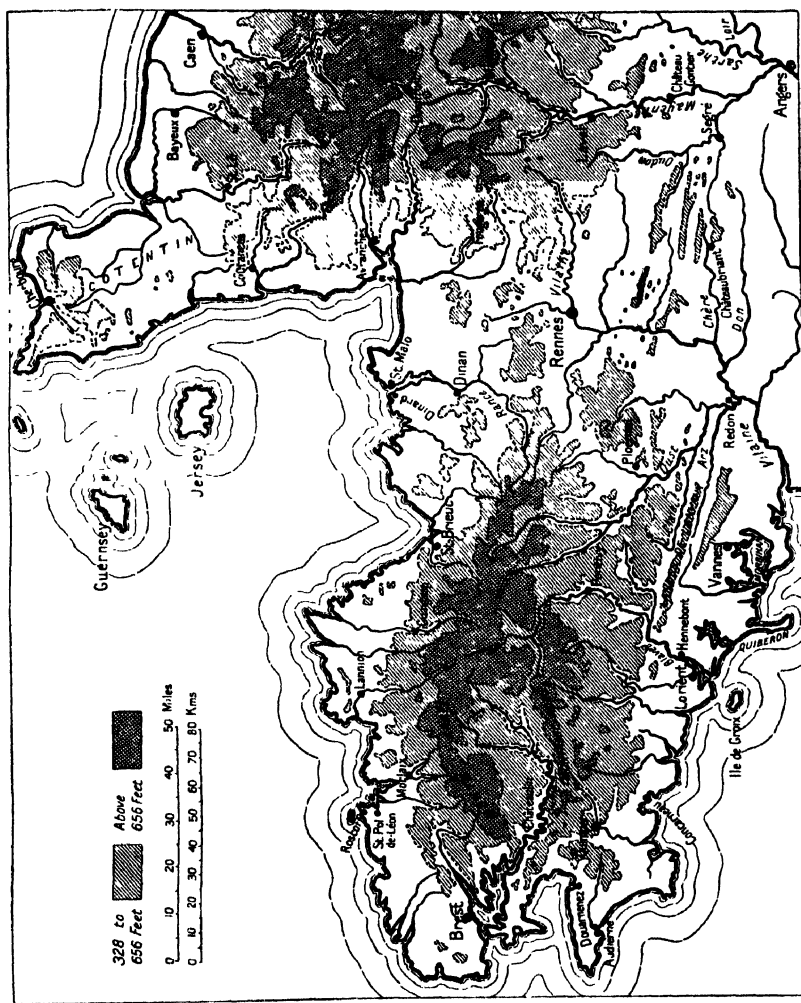


FIG. 20. THE ARMORICAN MASSIF. MAP SHOWING BROAD FEATURES OF RELIEF AND DRAINAGE. THE COASTAL AREAS MUST BE REGARDED AS CONSISTING OF LOW PLATEAUX RATHER THAN COASTAL PLAINS.

Jouan de l'Île must be surmounted before we cross the slate basin of Evran, after which we traverse the granite coastal platforms of Dinan and St. Malo, separated by a belt of phyllades which bounds the Bay of the Mont St. Michel.

What distinguishes the relief of the interior from that of the coastal regions is the fact that in the latter the dominant rocks

are the slightly upstanding platforms of granites and crystalline schists, with their mild relief and rounded forms, and with narrow etched-out bands of soft shales and clay slates occurring as minor features; whereas, in the interior, the major features are soft slates and the relief is provided by narrow ridges of quartzite or schist or an occasional swell of granite or other intrusive rock. In the west the ridges of sandstone are very conspicuous in the *Monts d'Arrée* and the *Montagnes Noires*.

This difference of relief between the coastlands and the interior is emphasized by the drainage. On the coastal platforms the water has etched valleys into the infolded strips of slate, so that the drainage takes on a herring-bone effect when depicted on the map. In the interior basins the drainage tends rather to the fan formation.¹

Impermeability is characteristic of the rocks of Brittany as of the rest of the Massif. This, combined with a comparatively heavy rainfall and the general humidity of the atmosphere, has produced a furrowing of the surface by innumerable water-courses. There is very little percolation of water into the sub-soil, however, and there are few permanent springs, so that, as in the Central Massif, when a period of drought does occur the lack of water becomes serious, and in most summers the vegetation assumes a yellowish, parched appearance that is aggravated by the constantly rising dust from the sandy roads and the absence of running water. In the basins where Tertiary or alluvial sands predominate, as in the *Pays de Coislin* north of the *Loire* estuary, the lack of water is a normal condition.

Generally speaking, one is justified in describing the climate of Brittany as maritime.² The winters are very mild, the summers, in the coastlands, are cooler than in the continental areas. There are frequently cloudy skies and strong winds. The rainfall is fairly heavy and the maximum occurs in the autumn. As one would expect, conditions become transitional between maritime and continental as one moves inland from the peninsula towards the Paris basin. (What is perhaps a little surprising is the contrast between the coastlands and the interior of the narrow peninsula itself. This is due to a large extent to the relief. The humid air of the coastal plain does not penetrate easily into the interior basins. The range of temperature is markedly higher in the interior. On the other hand, the rainfall is higher in the interior than on the coasts, precipitations being augmented by the abrupt ridges of the *Monts d'Arrée* and the *Montagnes Noires*. Snow often lies in winter on these hills, while it is rare on the coasts. The rainfall is more evenly distributed

¹ Figs. 19 and 20.

² See chapter on Climate, p. 7.

throughout the year on the coast than in the interior.) It is not uncommon inland to experience great heat in summer, accompanied by severe thunder-storms. This is rarely met with on the coast, where, however, in winter, high winds and storms are frequent.

The *bocage* type of vegetation prevails over the whole peninsula, the main distinction being that tree growth disappears as the coast is neared. This is due to the prevalence of strong winds. Bracken, bramble, hawthorn, and gorse clothe the turfed walls, however, right down to the edges of the tidal inlets in the south. Bracken is ubiquitous. Gorse predominates on the sandstone ridges or where the granite weathers into loose sand. With it, here and there, a little heather relieves the monotony of colouring. Rows of trees, pollard oaks chiefly—forlorn, bristling objects whose lower branches are lopped for fuel, litter and even fodder for cattle in the dry weather—grow between the fields. Coppices of oak with crowded, wispy stems are common. The sandy ridges are often dark with plantations of conifers, as on the Landes de Lanvaux, and from time to time plantations of sweet chestnuts occur. The valley-bottoms have lines of poplars following the watercourses.

Cultivation is carried on over the whole area, whether the underlying rocks be crystalline or slate. The slates weather into sticky, clayey soils, the granite into equally sticky clays and coarse infertile sands. The granite sands, the basins of Tertiary and alluvial sand, and the hard sandstone ridges are usually abandoned to *lande* or 'rough', as it would be called in Sussex; though pine and sweet chestnut are reclaiming much of it for economic purposes. The clay soils, whether formed from the granites and schists or from the slates and shales, are almost universally poor. Their profitable utilization for agriculture depends very largely upon the possibility of 'amending' them, and this is to a great extent a matter of transport facilities. In dry weather road transport is comparatively easy throughout the peninsula, but through the long winter and spring the hollow lanes leading to the little farms are almost impassable, and although there is marked improvement in road-conditions, many of the roads bearing the title of '*chemin de grande communication*' are not much better. The soils of the granite coastland can be improved at comparatively low cost, for Nature has provided excellent material for lightening and liming the heavy clay in the shelly sands which occur round the coasts.

Yet the cost of transport makes the utilization of this fertilizer almost impossible for the peasant of the interior, although the slaty clays of the interior are quite as needful and susceptible

of improvement as those of the coastal plateaux.¹⁾ Light railways, motor transport and concentrated artificial fertilizer are doing something to help the peasant of the interior, but the advantage still lies with the coastal plateau. The marine climate has added another advantage to that of accessibility to all those regions that are sheltered from violent winds. In all the sheltered bays the mild and equable temperature encourages the cultivation of *primeurs*—early maturing potatoes, onions, tomatoes, and vegetables of all sorts—which find a ready market in the larger French towns as well as on the other side of the Channel.

We have said sufficient to show that, whatever other geographical divisions it may be convenient to make in the study of Brittany, the division between the coastal platforms and the interior basins and ridges is fundamental from the view-point of human geography, and justifies a separate description. The Bretons themselves speak of the Armor, the land of the seaboard, and of the Arcoat, the lands of the woods or forests—the *bocage*.

ARCOAT. In the *bocage* lands of the interior the farms are small and generally isolated; they avoid the bleak hill-tops, which are often given up to moor or wood, and the marshy valley bottoms, which are devoted chiefly to pasture and hay meadows. They are placed most frequently near the hill-tops where water is available. The often tiny fields are almost hidden behind their high banks of furze and bracken studded with stunted oaks, and the passer-by must look through the gates to discover the crop of buckwheat with its creamy flowers or stacked crimson stalks, the meagre field of rye with a few apple trees dotted among the grain, the little plots of cabbage or potatoes. The prevalence of buckwheat as the major crop is the sign of a poor soil.

The villages are often shabby, stretching a dreary length of tumbledown cottages and farm buildings along the narrow high-road. The communal centres number from a couple of hundred to one or two thousand inhabitants, usually containing less than half of the population of the commune. The farmhouse and buildings usually form an oblong under one roof, or the house projects to form an L. The yard is generally separated from the road by a rough stone wall. Building material varies with the opportunities offered by the locality. The high-pitched roofs may be of tile or slate, usually the latter. The walls may have a substructure of stone while the rest is of *torchis*—timber and clay—not weather-boarded. In districts where granite is available, the farms have a more solid appearance, though the dark, heavy stone, unrelieved by paint or whitewash, and the

¹ Gallouédec: *La Bretagne*, 1923, p. 25.

general absence of flower-gardens give an air of gloom to the habitation. Sometimes the local material is schist or slate. Then the flattish slabs of stone are embedded in a pinkish plaster which lends the buildings a curious mottled appearance.

The lack of lime in the soils of the interior prevents the rearing of a bulky type of cattle, the small red and white or black and white cows of Brittany contrast strongly with the powerful fawn-coloured beasts of Loire-Inférieure. Nevertheless, the Breton cows are good milkers, and some of the larger clay basins have good pastures, as in the basin of Châteaulin. Butter, varying greatly in quality, is brought regularly into market and forms an important article of diet and export. The basin of Rennes, owing to the accessibility of limestone on the rim of the Paris basin, has better agricultural and pastoral conditions.

The roadsides and hedgerows are grazed, especially in the dry weather, when grass is scarce, by cattle and sheep. It is a common sight to see a group composed of a couple of cows, a sheep, or goat, a small child with a switch and a devoted dog in occupation of the highway. Sometimes the child is replaced by an old woman, who knits or winds from a distaff as she goes. A fleece of wool drying in the sun outside a cottage door reminds one that these isolated settlements still need to a large extent to be self-sufficing.

The general impression one derives from a journey across the interior of Brittany is one of poverty and even of squalor. This is particularly so at the end of a hot summer, when the country lacks the freshness imparted by streaming water, when one wearies of the dusty roads, of the monotonous bristling hedges or parched bracken and furze and mutilated trees and the unpromising dreariness of the farms, with their stark stone buildings. And it must be confessed that the hard life and the isolation seem to have stamped an appearance of dourness upon the peasant folk themselves.

The population is much less dense in the interior than on the coast, being only about forty inhabitants to the square kilometre. It has for long been a district from which seasonal migration took place to the grain-lands of the Paris basin. It is an area that has lost population rapidly in the last fifty years to the large towns, Rennes and Paris, Le Havre and Angers.

(Pontivy, on the Blavet, in the department of Morbihan, is the largest town of the western interior) (La Basse Bretagne). It lies at the point where the Brest-Nantes canal reaches the Blavet and where the railway from St. Brieuc to Quiberon crosses the river; but the urban population only reaches 6,277.

ARMOR. The Armor, or coastlands of Brittany, differ in many respects from the interior. In the first place, the granite and crystalline schist, and the other hard rocks which predominate, have resisted weathering much more successfully than the softer slates of the interior, with the result that the peneplane has been but slightly impaired by erosion. The drainage is still immature, contrasting with the more developed hydrography of the interior. Only on the edges of the low coastal platforms do the rivers trench deeply into the hard rocks. The bands of soft slates folded into the crystalline rocks have, it is true, been worn into valleys but so narrow are they that there has been no room for lateral development and the streams flow in straight, narrow trenches. The surface of the crystalline rocks is rarely exposed on the coastal platforms; there are usually several feet of soil above the rock, so that cultivation is more general.

Certain outstanding features distinguish the north coast regions from those of the south, and again from the west. The northern platform is higher than the southern. There is evidence that the land once extended far to the north, which would explain the greater erosive work that has been performed by the northern streams, which have etched deeper into the hard rocks. In the north the advancing sea made its way into the deep ravines, which now form winding creeks with steep, rocky sides. The southern platform lies almost flush with the high-tide level, and the peneplane does not rise steeply from the coast, as in the north. Climatically, as we have seen, the coastlands differ from the interior, being more definitely maritime in character, having milder conditions, a moister atmosphere, less cloud, and less rain, and the south coast has milder conditions than the north.

All these physical differences are reflected in the social and economic life of the people. But the main distinguishing factor and the dominating influence is the proximity of the sea. It is the sea that gives unity to the coastlands, as the river basins do to the interior regions. The sea does not merely wrap round the Armorican peninsula; it is intimately intertwined with the land, and among the innumerable islands, in the intricate bays and gulfs and the enclosed, island-studded seas, in the long, winding *rias*, forms as much a part of the *pays* as the land itself. The coastal development is as immature as the river development. Waves and tidal currents are ever busy buffeting and tearing at the projecting headlands, eating into any exposed beds of softer rock, cutting off a block here, isolating a mass there, and carrying the waste away to deposit it in the re-entrant

angles of the coast.) But the extreme hardness of the siliceous rocks, especially in the north, makes the process a slow one, and the coast line still reflects very closely the conditions of relief that prevailed when the advance of the sea took place in Quaternary times. The effect of shallow seas combined with the irregular nature of the coast-line, the jutting promontories, and numerous islands and narrows have given to Brittany a remarkable system of tidal currents. The tidal range is everywhere high along these coasts, and the currents in many instances form races having a dangerous velocity.¹ At the head of the Bay of Cancale, for instance, the sea at low tide almost disappears from view. At St. Malo the water recedes completely from the harbour, and the Channel boats have to land their passengers in *vedettes*. At high tide, on the other hand, the water rises rapidly to a depth of from 24 to 36 feet. In the gulf of Morbihan, the sea retires leaving an unpleasant expanse of mud that stretches for miles, to contrast with the clear peacock-coloured waters that fill the bay at flood-time.

The sea has given to the people of the coasts a dual life. Whereas the inhabitants of the interior are almost wholly engaged in agriculture, those of the coastlands are both agriculturists and fishermen or mariners.

(The crystalline rocks of the coastal platforms have weathered into heavy clays or loose sands.) In places remnants of Tertiary and Quaternary deposits provide sandy or clayey soils. In the north, broad expanses of a loess-like formation cover the coastal platform, probably relics of continental conditions when the land extended far to the north. This provides an exceptionally fertile soil. As a general rule, however, the soils of the Breton coasts are no more naturally fertile than those of the interior. The sandy areas are particularly barren, and the clays are very heavy and hard to work, and, like all the soils of Brittany, are lacking in lime.) But the coastlands have from time immemorial been improved by means of the application of shelly sands, which abound at intervals along the coasts, as, for instance, in the Bay of Cancale, or of *maerl*, which is a mixture of small algae, sand, crushed shell, and fragments of green slate.² Masses of shells of all descriptions are washed up by the tide and ground into fine particles, which mingle with the coarse sands and form great banks, which can be reached at low tide. The lighter soils are dressed with seaweed, the gathering of which forms an important occupation among the fishing population, especially in the north and west. The long, winding creeks, which can be navigated by

¹ *North Coast of France Pilot*, Washington, 1928, p. 172.

² Maicel A. Hérubel : *La France au Travail—en suivant les Côtes*, p. 223.

barges at high tide, make it profitable to bring these manures more than twenty-five miles into the interior.¹ The getting of seaweed is officially regulated. It may only be cut during the spring equinoxes at a stated time, and the mayor of each maritime commune is responsible for the control of this harvesting. It is usually cut by poor men and women, who sell it to the farmers. Storm-wrack may, however, be collected at any time, and it is a common sight to see the little two-wheeled carts struggling up from the shore laden with dripping weed. Although the calcareous and shelly sands are invaluable for liming and lightening the heavy non-calcareous clays that cover the granite, and are also transported by boat and by cart to the farms of the littoral, to-day the increasing use of artificial manures is making the getting of lime and seaweed a less important industry. The relative fertility thus artificially produced, or due to deposits of loess, has made the cultivation of the coastal platforms less heart-breaking a task than that of the interior. Farming is as a rule definitely more prosperous in the Armor than in the Arcoat. Buckwheat is not the main crop here; the cultivation of wheat is usual and the use of white bread more common. Of course, on the more exposed parts of the coast there is no cultivation, but, as if to compensate for this 'savagery', the sheltered bays with their mild, marine climate give rich opportunities to the market gardener. This is particularly the case on the northern coast of Finisterre, where cauliflowers, early potatoes, onions, and salads are grown for export.

Market Gardening. Three factors have co-operated to encourage the development of market gardening on the coasts of Brittany: protection from gales, low range of temperature, and rich soil. The shape of the coast provides bays sheltered from the blustering westerly gales, where the mildness of the maritime climate can have full effect, and there is a tendency to silting of all the re-entrant angles of the coast. The *rias* themselves have the same tendency, observable particularly at their mouths, but the tidal scour between the steep banks counteracts this, whereas in the open bays and gulfs the tidal currents and waves are continually depositing the rock waste that they tear from the jutting portions of the coast and grind to fine fragments. Thus a steady land-building is taking place, which, aided by artificial means, has led to the reclamation for pasture or cultivation of a considerable acreage. A good example of this may be seen in the reclaimed Marais de Dol, in the bay of Mont St. Michel. The marsh occupies what was a bay in the Middle Ages. Mont Dol, a striking feature even to-day, 2,100 feet above sea-level, was a

¹ See page 85.

rocky island of granite, like Mont St. Michel. Protecting walls, finished in the eighteenth century, keep out the tides, and artificial drains carry off the land water. Potatoes form the main crop of this intake. If we cross the one time marsh to Le Vivier-sur-Mer and follow the coast road towards Pontorson, we shall see all the stages of reclamation going on, both natural and artificial. At low tide the sea recedes almost out of sight, leaving long stretches of slimy mud. Between ordinary high-tide level and the embanked road stretches a belt of salt marsh raised two to five feet above the tide-washed levels. It is composed of layers of shelly sand and peat, and is covered with a fine tough grass. These salines form a first stage of reclamation, and provide valuable pasture for sheep and cattle. Within the embankment the land is divided into strips of pasture, osier beds, and cultivated plots. The farms lie stretched for six miles along the sea-front from Le Vivier to Ste. Anne. They are massively built of granite or schist. The large middens occupying the farm-yards are very important in the economy of this type of farming.

We have already mentioned the loess-like loam which covers the infertile and impermeable rocks of the crystalline platform along the north coast of Léon and Trégorrois. Morlaix, Lannion, St. Pol de Léon, little tidal ports, all send out potatoes and cauliflowers in addition to the barley, pigs, eggs, and butter of the hinterland. Roscoff is the seaport which deals with the produce of the coastal strip of north Léon from Lannion westwards, where perhaps the most intensive marsh cultivation has developed. The port also receives *primeurs* from the district of Nantes for export. The coastlands share in the dairy industry of the interior. The Breton cow, though small and slight, owing to the deficiency of lime in the soil, is a good milker, and Brittany butter is still an important article of export, although the superior marketing organization in Denmark and Holland has pushed that of Normandy and Brittany into the background. Butter enters into the list of export commodities of all the Breton ports in larger or smaller quantities.

Fisheries. But though the sea has its part to play in assuring the land harvests, it provides a variety of harvests that are peculiarly its own. The Breton of the *ria* coast is bound to the sea as closely as the Norwegian to the fjord. Fishing is of various types, according to the coasts and the seasons. On the north coast from St. Malo to Paimpol, deep-sea fishing occupies a considerable section of the male population. The fishing for cod on the Newfoundland banks of St. Pierre and Miquelon, the last remnants of French possession in North America, draws a

number of men year by year from St. Malo and the neighbourhood.¹ Paimpol sends its men to the Iceland cod-fisheries. The number of schooners has tended to diminish, but some fifty boats leave the French coast every year. Coastal fishing occupies a large number of men, but many of them are only part-time fishermen, who become farmers in the summer. The most important of the centres for deep-sea fishing on the European coasts is Groix on the island of the same name opposite the Rade de Lorient (*ria* of the Blavet). Here centres the tunny-fishing, which extends down the coast to Spain. In the summer months coastal fishing for herring, mackerel, and flat fish of all sorts is carried on from Lorient and St. Malo and all the innumerable small ports round the coast. Steam trawling is gradually being introduced, and in most ports the small auxiliary motor is now established. The industry is on the scale of that of the smaller coastal towns of Devon and Cornwall. It is mainly of local importance, like the subsistence farming. Still more scattered and unorganized is the fishing for shrimps, shellfish, lobsters, eels, etc., which is carried on regularly by all the inhabitants of a coastal village or hamlet at low tide, but particularly by the women and children, as an interlude to the work of the farm. The cultivation of oysters is an industry that has assumed importance in the bay of Cancale, and employs some 600 women and children. In the silted *ria* of Etel, between Lorient and the promontory of Quiberon, at La Trinité, near Carnac, at Carnac itself, and again in the *ria*, or *Rivière*, of Auray, which opens into the Morbihan, a couple of thousand people are occupied in oyster culture. Brittany oysters fetch a high price at Billingsgate. Other shellfish are caught all along the coast between Lorient and Quiberon. The great, spiny lobsters, called by the French '*langoustes*', are brought from the coast of Portugal and Morocco to Roscoff, Audierne and Concarneau and parked in tanks till they are ready for sale. They used to be found in numbers round the Breton coast itself, and are still fished for in a desultory manner round the coast of North Finisterre.

The sardine fishery is confined to the warmer waters of the south coasts of the peninsula, particularly in the department of Finisterre. Belle Isle, the ports at the mouth of the Rade de Lorient (Gavres and Port Louis), Concarneau, Audierne, and Douarnenez are the chief sardine ports, and depend almost for their existence on the sardine industries. The ports of the coast of Morbihan are also interested, but to a lesser extent, in sardine

¹ The Lansdowne-Cambon Convention of 1904 did away with the French fishing rights on the French Shore (west coast) of Newfoundland.

fishing. Douarnenez and Concarneau send out about 1,500 little boats, each manned by half a dozen men. This is an autumn fishery, and the sardine boats go a-fishing for skate in the winter months.

We have already mentioned the getting of seaweed. This is harvested chiefly round the north-west coast, at Trez and Plouescat, for instance, and round the islands off the Roscoff coast. The chief types of algae are the brown ribbon-like *laminaria* which grows in deep water and can only be reached for cutting at spring tides, the *fucus*, including the familiar bladder-wrack, which flourishes between high and low tide, and the fine whip-like *himanthalia*, which can also withstand the strong surf and rapid currents of the Atlantic coast. The sea-weed harvest, which takes place at the spring tides, is regulated by ancient custom. It lasts two or three days, between sunrise and sundown.

Certain other industries are based upon the fishing industry. By far the most important of these is the preserving and canning of sardines, which is carried on in all the little ports of the south coast. This work is largely in the hands of women, who gut, salt, and dry the sardines, boil them in oil, and pack them in boxes. These are then passed on to men workers to be closed either by hand or by machinery, and the final process of sterilizing and hermetically sealing takes place. The tins are stamped out at Hennebont, at the head of the Blavet *ria*. Here also are made tins for the preserving of vegetables—beans and peas. The pig-iron and coal for the industries have to be imported. In connexion with the 'fishing' for seaweeds, the industry of burning kelp or *goëmon* for fertilizer is carried on. In the south, in the neighbourhood of Vannes, for example, the ash of seaweed is treated to obtain sodium carbonate, sodium chloride, potassium sulphate, and chloride, as well as iodides and bromides.

We see what a variety of occupation the sea provides for the inhabitants of Armor. A very large number of people are able to obtain a poor living, and there is usually some occupation that a man can turn his hand to. Hence the dense population of the coastlands. The fisherman-farmer needs a large family to assist in the farm labour, to mind the beasts, to gather seaweed, shrimps, shellfish, to help his wife on the farm while he is away fishing. In the sardine areas of the south and west coasts there is occupation for the girls and women of the family in the packing-factories. The whole family may be engaged in one stage or another of the sardine industry. For this reason tiny hamlets and scattered farms are less frequently met with along the south coast—the population tends to crowd into the little ports, and we have

tenement houses occupied by several families in the sardine ports, for the sardine-packers must be near the quay to deal with the fish the moment they are brought in. One serious drawback to the inclusion of a whole family in the sardine industry is that when the season is bad and the fish are scarce there is no farm or market-garden to fall back on, and great distress prevails.

Along the north coast the sheltered sandy bays, rendered picturesque by the jutting rocks, have made possible the development of a number of *plages*. The Southern Railway's packet service from Southampton to St. Malo brings a large contingent of English visitors every summer to this watering-place and the neighbouring Dinard. Charabanc excursions to such places of interest as Mont St. Michel, and the megaliths and stone avenues of Carnac are further attractions. The improved roads are making Brittany, both coastland and interior, better known to the tourist ; but the interior has little in the way of picturesque scenery to offer to the holiday-maker, and again the coastlands have the advantage.

Brittany shows us then a typical example of the *bocage* country that results from a somewhat low-lying mass of land composed of infertile and impermeable rocks in a region of maritime climate. The scattered nature of the population, the tiny holdings, the general backwardness and poverty of agriculture, where the food-crops are buckwheat and rye, are to a large extent due to these conditions of subsoil and soil. The poverty of the land, rather than its peninsular nature, has led to the retaining of the Breton tongue in the west, or Bas Bretonne, and to the survival also of many ancient customs and superstitions such as still obtain in western Ireland. The coastal lands are just as ill-favoured as the interior so far as natural fertility of the soil goes, for the granite and schist are as impermeable as the slates of the interior and weather into soils just as infertile. The sea, however, has made all the difference, providing fertilizer for the fields, cheap means of transport for the farmer in the tidal *rias*, an alternative food-supply and a large number of occupations to eke out the parsimonious gifts of Ceres. Traffic with the outside world, relatively cheap coal, oil, and timber, have aided in the establishment of industries, such as preserving fish and vegetables, ship-building, salt-getting, furniture-making (as at Auray), all of which has helped to give the coastlands of Brittany the densest population of the whole of France.

In spite of the opportunities, afforded by its position, for coastal trading, cross-Channel trading, and transatlantic trading,

the restricted nature of the hinterland of Brittany has prevented the development of large ports in the peninsula. *Brest* has all the local advantages of deep water and a broad, natural harbour sheltered from storms, which are required by a great naval port and arsenal. It lies at the mouth of the Penfeld *ria* on the north side of the great landlocked sheet of water known as the Rade de Brest. The converging ends of the northern and southern archæan platforms in Finisterre embrace a zone of softer Silurian rocks which have been worn down to form the basin of Châteaulin. The Rade has over 30 feet of water at low tide. The modern naval port has developed outside the Penfeld *rivière* on the edge of the *rade*, where basins have been constructed to accommodate the modern cruisers, torpedo boats, etc., and to give them space to manœuvre. The commercial port lies, protected by moles along the *rade* above the mouth of the Penfeld. The hinterland of Brest is a hinterland of the neighbouring coasts rather than of the interior. The basin of ancient sedimentary rocks is not very productive except near the coast, where, for example, the district of Plougastel-Daoulas produces large quantities of strawberries, which are exported via Brest to the English market. The slaty rocks of the basin of Châteaulin, which lies farther inland between the sandstone ridges of the Monts d'Arrée and the Montagnes Noires, and is drained by well-developed tributaries of the Aulne, are not very productive, partly because the communications in the basin are poor. A light railway connects Châteaulin with Guingamp and Paimpol, and the canal from Nantes to Brest connects it with the latter port. But main roads are few, and there is very little traffic. The chief occupation of the basin is the dairy industry. On the other hand there has developed a regular coasting trade along the Channel to Dunkirk and down the Bay of Biscay and round to Algiers. Iron-ore, pig-iron, and coal from England, timber and ice from the Baltic and Scandinavia, pyrites from Spain, superphosphates from Belgium, these are the chief imports from abroad, direct; but Dunkirk and Le Havre send on such goods as mineral oils, cotton, coffee, nitrates, while coastwise come food-stuffs, such as sugar, grain, and wine. These goods are consumed locally by the population of Brest, some 79,000, or go to feed local industries. A small proportion is distributed in the immediate hinterland by land or water, together with the manufactured goods from the town itself. The ship-building yards and the arsenal absorb most of the heavy goods, local flour mills take the grain. About half a million tons of goods are redistributed coastwise to French ports, and about a quarter of a million tons, mainly of fruit, fish, and vegetables, are sent abroad. We see, then, that as a

commercial port, Brest does not rank high. The reasons are, in the first place, the poverty of the hinterland, and secondly, the bad approach to the roadstead. The entrance—Le Goulet—to the Rade de Brest narrows to about half a mile, increasing thus the safety of the roadstead and making fortification of the entrance easy. But the narrowness of the entrance, the strong tidal currents,¹ the frequent Atlantic storms, and, worse still, the fogs on a rocky coast make insurance for transatlantic service too heavy.² St. Malo has important channel ferry service for passengers and goods, and from the economic point of view is a more useful port, in spite of the great tidal range which leaves the harbour dry at low tide and makes it necessary to land passengers in *vedettes* at low water, or to make them wait half a day to embark or disembark their luggage.

Roscoff is a small port with very little up-to-date equipment. It is, however, the outlet for the intensive *primeurs* cultivation of Trégorrois and Léon on the northern coastal platform, as well as for the butter, eggs, and pigs, cauliflowers, onions, and potatoes from the market of St. Pol. The position of Roscoff is interesting as illustrating the silting that is accompanying the coastal weathering of the Armorican peninsula. The town was originally situated on the west side of the promontory on which it stands, but as a result of the assaults of sea and of the enemy from across the Channel in the Anglo-Norman wars, the population migrated across the promontory.

For the south coast of the peninsula, from Concarneau eastwards, the collecting and distributing centre is Nantes, with its port of St. Nazaire. It serves the same hinterland as Brest, Lorient, and St. Malo, incidentally to its work as outlet for the lower Loire regions.

Lorient (population 40,809) is a specialized port. It originated in ship-building yards established in 1664 at the time of the inauguration of the Compagnie des Indes; hence the name which it received later. In 1690 it became a naval port, but it has none of the advantages of Brest. Its *rade*, or *rivière*, of the Scorff is narrow and not very deep, and commercially the port was of little consequence down to the end of the nineteenth century, mainly because of lack of a developed hinterland. A bold scheme of reclamation of waste land amounting to 120,000 acres and the improvement of means of communication paved the way for modern developments.³ Land that was unsuitable for agriculture was devoted to pine plantation, and the pit props thus produced

¹ See *The Bay of Biscay Pilot*, Washington, 1926, pp. 111-13.

² See Hérubel: *La France au Travail*, p. 238.

³ The new port of Kéroman at Lorient is the second fishing port in France, handling about 33,000 tons of fish, or just over one-tenth of the French total.

furnish a most satisfactory return cargo for the Welsh coal imported for Lorient and the smelting works of Hennebont, six miles away, on the Blavet *ria*.

East of a line from Lorient to St. Brieuc the influence of the Paris basin begins to be felt. French gradually becomes the language of the people, rather than Breton, and lines of communication begin to converge on Rennes.

The basin of Rennes in Haute Bretagne is separated from the rest of Brittany by a zone of crystalline rocks trending south-south-east from St. Brieuc. This zone rises to 1,000 feet in the Landes du Mené, which form a gathering-ground for streams draining southwards to the Vilaine and northwards to the bays of St. Brieuc and St. Malo. This is a negative region of poor communications and contains no town of any significance. It is traversed by the high-road from Brest to Rennes via Loudeac, and by that from Vannes to St. Malo described in the early part of this chapter. Rohan, Maunon and St. Méen are local markets. The basin of Rennes lies sunk between the crystalline plateau of the Mont St. Michel, edged with a narrow ridge of hard sandstone, and another zone of Silurian sands to the south. The basin has been worn in soft Silurian shales, but there are numerous outcrops of harder rock which give the floor a broken, undulating appearance. In the neighbourhood of Rennes, to the north-east and north-west, there are broad belts of ancient alluvium, formed of sands and clays, belonging to the upper Pliocene period. The sands bear woods, such as the Forest of Rennes, to the north-west of the town. The clays are cultivated where the conditions are not too marshy. The relatively large fields, the replacement of rye and buckwheat by wheat, the richer pastures are evidence of the easy access to lime and of good rail communications. The general elevation of the centre of the basin is between 100 and 130 feet. It is drained by the Vilaine and its tributaries, the Alleeu, which skirts the edge of the Armorican sandstone Massif of the forest of Paimpont in the west of the basin, the Ile, which cuts across the grain of the country from the north, and the upper Vilaine, which comes from the plateau of Mayenne in the west and follows the line of soft clays exposed in the floor of the basin. The basin of Rennes forms the department of Ile-et-Vilaine of which Rennes is the *chef-lieu*. The town, apart from its function as administrative and University centre, is mainly a market for local agricultural and dairy produce. Its industries are also based on local products. It specializes in the preparation of hides and skins (particularly calf-skins) and in the manufacture of boots and shoes, and it employs some 300 persons in the preparation of pig bristles for brush-making, etc. Although a route centre of some importance, Rennes has never, owing to the

separating geographical influences, been able to focus the interests of the whole Armorican peninsula, which in the south looks towards Nantes and in the west towards Brest.

THE CONTINENTAL BASE OF THE MASSIF

The Armorican peninsula is attached to the main mass of the Continent by a belt of country which bears most of the characteristics of the Massif in its physical features, but which yet, to some extent, is affiliated to the basins of Paris and Aquitaine. This belt is structurally a part of the Armorican Massif which ends abruptly against the regions of younger rocks of the Paris basin and the Sill of Poitou, and it would be difficult to find greater contrasts than exist between the *bocage* area of the Massif and the Liassic clay vales and Jurassic limestone *campagnes* of the Paris basin. Nevertheless, climatically, and from the point of view of human geography, as a result of human contacts, this belt is transitional. Curiously enough, its various sections have little or no historical unity and the modern administrative units included have little geographical basis. Parts of Normandy, Anjou, Maine, Poitiers, and Vendée go to make up this continental base of the Massif; but the term *bocage* applied by the people to many sections of it is always with the idea of distinguishing it from the markedly different sections of the provinces that lie to the east. Thus the *bocage Normand* is that section of the *bocage* which abuts on the dry, open Campagne de Caen, the *bocage Manceau* gives place to the open, sunny country of the basin of Le Mans. All these regions have much in common with each other and with Brittany, which we have described in detail, and a short account should suffice to bring out such slight contrasts as exist.

THE NORMAN BOCAGE. That part of the Armorican Massif that belongs to Normandy is known as *le Bocage Normand*. It includes Manche and parts of Orne and Calvados. It may be conveniently divided into three parts: the Cotentin in the north, the *bocage* of Avranches in the south, and, between the two, the Marais or Low Cotentin.

The northern part of the Cotentin, a continuation of the northern anticlinal plateau of Brittany which passed through Guernsey and La Hague and is formed of granite swells, and valleys etched into soft precambrian slates, represents the great syncline between the north and south Armorican folds, but relics of more ancient, probably precambrian, folding have brought the granite to the surface in the anticline of Tinchebrai, and minor folds within the Hercynian are responsible for the

appearance of the crystalline rocks in the *bocage Normand*. The Marais or Low Cotentin, unlike the north and south plateaux, which appear not to have been submerged since primary times, has frequently formed a marine gulf, and is to-day floored with Tertiary rocks. It opens into the bay of *les Veyes*, and probably forms part of a much larger feature which includes the bay and estuary of the Seine. The *bocage Normand* differs from the Cotentin mainly in its continental rather than peninsular character, and also in the fact that its relief is generally higher. Apart from these differences of relief, the whole of Low Normandy presents the same *bocage* features that characterize Brittany: general impermeability of rocks, streaming of water over the surface in innumerable watercourses, rapid drying up in a period of drought, east and west striation of the country in ridge and furrow, prevalence of waste *landes* on the ridge-tops, general wooded appearance of the land (turfed banks dividing the small fields, with oak and elm, beech and nut), the importance of buckwheat as a crop, the prevalence of cider apple-trees in orchard and in field, the predominance of dairy-farming and cattle- and horse-breeding, and finally the scattered distribution of the population in small hamlets and villages and isolated farms.

Here also, as in the Breton peninsula, the proximity of the sea is a vital influence in the development of the country, increasing the fertility of the land by providing fertilizer in the form of seaweed and 'tangué', as the shelly sand is here called, for the cold, siliceous soils. The main point of difference here seems to lie in the orientation of the peninsula from south to north, i.e. at right angles to the graining of the land. This means that we do not find the coastal sections of the rivers cutting gorges through the hard rocks to reach the sea, and although the rivers are tidal like the *rivières* of Brittany, they do not flow through steep-sided winding gorges, like that of St. Malo. The east and west coasts of the Cotentin offer certain interesting contrasts. The east is somewhat more sunny and protected than the west, where the full force of the westerly winds is felt, and where the tremendous tidal races that rush through the Raz Blanchard and among the islands of the sinister Passage de la Déroute make navigation a real danger. Granville is the only port. Contrast this with the swarming ports along the Breton coasts. On the other hand, the east coast, where Liassic Clays form a coastal belt, shows a strong tendency to silt, and there are no good harbours. As in the rest of the Armorican peninsula, the tidal range is very great, and the rivers of the west coast are navigable for a dozen miles from the coast, as a rule, at high

water, for small barges up to twenty tons which carry marine fertilizers.

The proximity of the coast has had a beneficial effect on farming, which is relatively prosperous compared with the interior *bocage* lands to the south. There are considerable areas of *landes*, especially on the high-lying sandstones which have weathered into dry, permeable, sandy patches, incapable of irrigation. But the polders of the Bay of Veyes and of the Mont St. Michel form rich pastures for sheep or cattle, and the cultivation of *primeurs* for export is carried on all round the coast, particularly in the neighbourhood of Cherbourg. Buckwheat is the chief crop, because it does well on the siliceous soils, but wheat is grown on the Liassic Clays of the east coast plain. Dairy-farming and cattle-rearing are both important, as also is horse-breeding, though the foals are usually sold to farmers of the surrounding neighbourhood—the Caen area and Bessin. The cattle are of the Norman breed and are good milkers. Very little cheese is made. Butter is the chief product of the dairies, but is no longer an important article of export to this country, its place in the English market having been usurped by butter from Holland and Denmark. Paris is the chief market.

As in Brittany, fishing is an important auxiliary to agriculture. Granville sends its quota of boats each year to the Newfoundland Banks, and has cod-curing sheds, and there are the coast fisheries of the Channel. Oysters are dredged, especially in the neighbourhood of St. Vaast on the island of Tatihou, which has large oyster-parks.

Other industries dependent on local conditions are granite quarrying, particularly in the Isles Chaussey, whence came the granite employed for the building of the vast fortress abbey of Mont St. Michel. It is also exploited at Flamanville in Cotentin, where a great granite boss forms a promontory between two bays in the softer slates. Kaolin is worked at Pieux near by and is used for the well-known Bayeux pottery.

The Iron Industry. Most important of the extractive industries is that of iron. The mines are of special importance south of the anticline of Tinchebrai in the basin of Silurian slates which stretches west and east of Mortain. The ore is of the Minette type, but is richer than that of Lorraine, having an average of about 50 per cent iron.¹ The output of ore in the two departments of Orne and Calvados amounted in 1936 to two and a half million metric tons.²

¹ Janau : 'The Iron Ores of Normandy', *S. G. M.*, 1925, p. 275.

² *Revue d'Economie Politique*, May-June, 1929, p. 614 and 1930, p. 680. See also Chap. IV, p. 151, and *Statistique de l'Industrie Minière*, 1936.

The distribution of population resembles that in Brittany, but there is a less marked contrast between the density of the coast land and that of the interior. There are fewer ports, owing to the nature of the coast. On the other hand, the interior is less cut-off from the sea and from the Continent than is the case in Brittany. *Cherbourg* has a population of 33,469, about half that of Brest. It owes its importance to its strategic position on the jutting Cotentin peninsula which narrows by half the width of the Channel opposite to the British naval port of Portsmouth. As a commercial port it has few advantages. The roadstead, or *rade* is protected by an immense mole of granite running west from the Ile Pelée to a point opposite the Cape of Querqueville. It took over a hundred years to complete, at immense cost. The little town lies at the bottom of the bay thus protected, at the mouth of the Divette. The rocky western wall of the bay has been excavated to form the great military port, the basins being dug to a depth in some cases of over 50 feet in the slate rock. The original design was by Vauban, and the port is strongly fortified, as is also the mole. The arsenal specializes in the construction of submarines.¹ The Dielette mines, near Flamanville, provide the iron which is carried by coast from a special port recently constructed. Cherbourg exports *primeurs*, potatoes, and cauliflowers, particularly from the west coast of the peninsula. Granite and dairy produce are also exported, and the imports include food and stores for the arsenal, Baltic timber, coal, fertilizers from Dunkirk, and coffee, spices, and other foreign wares relayed from Le Havre. The modern arrangement by which American liners make Cherbourg a port of call affects chiefly the railway service and brings little grist to the mill of Cherbourg. Granville has a similar traffic to Cherbourg, on a smaller scale. The town stands picturesquely on the rugged, jutting promontory which shelters the little fort from the gales of the north-west.

THE BOCAGE OF MAINE. From the *bocage* of Normandy we pass south into the *bocage* of Low Maine or *bocage Manceau*. High Maine, which is the basin of Le Mans in the Jurassic limestone area to the east forms a contrast with the *bocage*, but the change is less abrupt than between High and Low Normandy. Low Maine belongs to the central slate basin of the Armorican Massif, and has all the characteristics that we noted in the corresponding areas in Brittany. Here, as in the basin of Châteaulin, the depression is bounded by a broad swell of crystalline rock, and here also the more emphatic lines of relief are provided by narrow lines of hard sandstone. These, however, do

¹ Hérubel : *La France au Travail*, p. 195.

not form such definite and continuous features as we encountered in the Mont d'Arrée and the Montagnes Noires, and the general aspect of the country is of a gently rolling type. The hills of Coëvron, converging on the hills of Normandy rise, it is true, to over 1,300 feet, but they have nothing of the steepness and abruptness of the Monts d'Arrée. The point at which the two lines converge is the highest in the northern plain of France. As in Brittany, a few patches of forest remain on the uplands to represent the great weald that once formed an almost complete barrier to movement and settlement. Woods of oak, beech, and chestnut occupy the higher ground here as in the Collines de Normandie, such are the forest of Sille on the Collines de Coëvron, and the forests of Pail, Multonne, Ecouves, and Perseigne on the crystalline and sandstone hills that ring round the Jurassic basin of Alençon, on the eastern edge of the district. The drainage is less complete than in Normandy. Marshy areas are common, particularly in the upper courses of the streams; for example, east of Mayenne where *landes* and peat bog take the place of forest. On the slates the forest has generally been transformed into pasture and agricultural land. Maine and Normandy have one great advantage over Brittany in that lime is obtainable inland, the Lias and other Jurassic zones on the flank of the Massif containing belts of limestone and limestone deposits lying within the Massif itself. Liming is commonly practised in the *bocage*, and wheat is an important crop. Cereals are actually exported. As in Normandy, however, the main use to which the land is put is pastoral. As the climate here is essentially maritime,¹ although actual rainfall decreases slightly from west to east and in places is actually below the average for the rest of France, humidity of atmosphere characterizes the country. In the winter mists arise from the numerous ponds, and for more than half the year the soil is spongy with water in the lowlands. Streams meander everywhere, to be gathered up for the most part by the Mayenne. This stream is the main artery of Maine, as the Vilaine is that of the basin of Rennes and the Aulne of the basin of Châteaulin.

If we follow the *Mayenne* from its source to the Loire it will give us an opportunity of noting in more detail the features not only of the geography of Maine, but also of its southern neighbour, the *bocage* of Anjou. The river rises about three miles from Pré en Pail in the cusp formed by the Collines de Normandie and the ridges of the Coëvron. It passes first westward through a high-level slate basin along the foot of the hills of Normandy and is followed by national road and railway to Domfront. The

¹ Angot: 'Régime Pluviométrique de la France' (*A. de G.*, 1917).

edges of the basin are dotted with villages, which are only found on the river when the road descends to a bridge. Every tributary has one or more hamlets or villages, which are usually some distance up the slope. At Haleine the river turns south, leaving road and rail, and directs itself towards the Loire. It crosses one after another the softer and harder outcrops of rock, widening and narrowing its valley accordingly. Some thirty miles from its source stands Mayenne, originally a feudal castle protecting the crossing of the river, but developing as a bridge town and as a small manufacturing town with a textile industry based on the power provided by the Mayenne, now a considerable stream. Its narrow streets rise steeply from the river on either side of the bridge. It has steadily decreased in importance in the latter half-century. Its population in 1891 was 11,000, in 1921 it had been reduced to 9,000, and in 1936 stood at 6,480. On leaving Mayenne the river entrenches itself in the granite plateau which separates the slate vale of Mayenne from the Carboniferous basin of Laval. As it deepens its valley the population avoids its banks, and the few isolated farms and hamlets cling to the plateau. The high-road to Caen avoids the valley and keeps to the plateau. The Roman road, traces of which can be found in ancient tracks and minor roads, followed the plateau to the east, passing through the castrum of Jublain, seven miles to the east of Mayenne. The tributaries of the Mayenne in the crystalline block are short, but follow north-west to south-east furrows etched in the softer rocks according to the Armorican graining of the peneplane. The valley now opens out into the Carboniferous basin of Laval, which, in many respects, resembles that of Châteaulin, with its rim of granite and Armorican sandstone hills. Like Mayenne, Laval owes its origin to a feudal castle and its growth to water-power for textile industries, to the converging of roads on a bridge, and the development of a market for the produce of the basin. To-day the river is canalized, and is navigable for small boats up to Mayenne, thanks to a large number of weirs. The population of Laval has slightly increased and reached 26,219 in 1936. At Château Gontier, a little market of 5,900 inhabitants we are still in the clay zone, and the altitude of the town is only 140 feet.¹ *'Mayenne et Château Gontier réduction de Laval, reproduisent le type de ces sous-préfectures tranquilles dont la somnolence s'anime de loin en loin, aux jours de fête, de marché ou de foire.'*²

THE BOCAGE OF ANJOU AND VENDÉE. The *bocage* of Anjou lies to the south of the *bocage* of Maine, and is for the most part within the department of Maine et Loire. It is drained by the lower

¹ cf. Mayenne, 400 feet.

² Gallauédéc, *Le Maine*, p. 16.

Maine and its tributary the Oudon, which unite just below Le Lion d'Angers, about a dozen miles above Angers itself. The peneplane continues low, rising rarely above 330 feet. The only marked features of relief are ridges due to narrow belts of hard Armorican sandstone which hem in vales worn down in slaty rocks of various ages from early Cambrian to Carboniferous. The basin of Pouance-Segré, traversed by the Oudon at Segré and drained from the west by a tributary of that river, the Verzée, is the most noteworthy. The sandstone ridges are usually wooded with oak and chestnut. They have a certain economic importance, because they contain iron, which is worked here and there as at Soulvache. The position of the iron deposits is interesting, as contrasting with that of the deposits in the Norman *bocage* which, are always found in the shales.¹ Among the numerous narrow zones of slaty exposures, bands of roofing slates are important. They are quarried in a number of places, for example near Renaze, between Craon and Pouance, and again between Segré and Pouance; but by far the most important quarries are those of Trélazac, five miles to the south-east of Angers.

Angers is the capital of the province of Anjou. If you approach it from the direction of Saumur, as you climb the low plateau of ancient slates that separates the valley of the Mayenne, or Maine as it is called, in its lower course, you will see on the skyline a confusion of church spires and chimneys. The town stands on a hill, overlooking the Maine about five miles from its junction with the Loire, at a point where the river narrows to cut through a bed of harder rock. The main road from Saumur passes through La Cité—a depressing suburb of miners' cottages—for about two miles before reaching the old town at the top of the hill, dominated by the cathedral. The wide, ugly, modern street, with its tram-lines, narrows suddenly when the line of the old wall is passed, and one finds oneself in a labyrinth of twisting, narrow lanes, often very steep, with timbered and gabled houses lying in the shadow of the cathedral: a typical border city. The massive keep, with its seventeen great towers, lies on the western slope of the hill overlooking the Maine. Like the cathedral and the rest of the town, it is built of dark slate rock, but bands of white stone encircle the towers. Angers is now a manufacturing town of some importance, with a population of 81,000, a large number of whom are slate-miners. The Loire is navigable with some difficulty between Angers and Nantes. Ancenis, which lies about twenty-seven miles downstream from Angers, is the only other important centre of the Angevin Massif. The belt of

¹ Dr. O. Couffon and Prof. Dollfus: *Geology of the Maine and Loire*. Issued by the Geological Association, 1928. Note p. 11.

Carboniferous rocks, preserved in narrow synclines, which extends in a curve following the general graining of the country from the Pointe de Raz, crosses the Loire obliquely in a belt that covers Ancenis and Chalonnes-sur-Loire. The wide, braided course of the Loire narrows here to a single stream, though the suspension bridge that crosses is over a quarter of a mile long. The narrowing is due to a band of hard rock at this point. The castle, which is in ruins, lies in the usual position, just above the descent to the bridge. The population of the little market town is only about 3,300. South of the Loire, the palaeozoic slates cease to predominate.

The Vendéean Massif is a continuation of the southern crystalline platform of Brittany. Through the centre of it runs a great whale-back of granite, twenty-five miles broad at its widest, forming the region known as *the Gâtine*. The Mauges to the north, between this mass and the Loire, and the *bocage* Vendéean proper to the south, are composed, like the Brittany plateau, of alternating zones of Mica schists and palaeozoic slates. (The main differences to be noted as one passes southward through these *bocage* lands are due to an increase in summer temperature.) The vine becomes more and more common, maize becomes a more frequent crop, melons ripen, oleander and palms grow in the open.) But the *bocage* appearance persists: fields are still smallish, trees still crowd the hedgerows—oak, nut, bramble, and hawthorn—and buckwheat is still a common crop. The houses are built of schist, but we see more frequently low-pitched tile roofs instead of the steep slate roofs of the north. On the ridges the gorse reappears in the hedges, and pine, oak, and chestnut plantations are frequent, the latter becoming more important. The south-facing slopes of the Sèvres valley are rich in vineyards. Here the hedges disappear. The Sèvres flows from its source to Clisson, through the length of the granitic mass of the Gâtine, and most of the life of the region is in its valley. The ridges are sandy soiled and given over to rough moor, bog and coarse pasture, but the valley slopes are cultivated and there is an air of greater prosperity than the *bocage* lands of the north and west can boast. The farms and houses are often whitewashed, which, together with the red tiles, give the villages a more cheerful aspect than those of the sombre Breton villages. We are in a zone of transition between the north and the Midi.

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THE PARIS BASIN

THE Paris basin has been variously defined, even by the geologists. Usually it is regarded as the depression lying between the Armorican, Central and Lorraine Massifs, filled by deposits of the Cretaceous seas, composed in the main of thick layers of chalk, underlain by Gault Clay and overlain by immense thicknesses of Tertiary deposits.¹ One advantage of this definition is that it gives us a geological unit of relative simplicity. As a matter of fact, however, the geologists tell us that the geological basin underlying Paris and the centre of the Seine basin goes very much deeper than the Cretaceous deposits; moreover, although with a much less symmetrical arrangement than that exhibited by the chalk, the sequence of exposures arranged in concentric zones from the centre of the geological basin is continuous, outside the chalk, to the base of the Lias. True, it is only in the east that these exposures are found greatly developed. This is partly due to the great elevation of the eastern section of the rim of the basin and the resulting greater river development, but also due in part to asymmetry in the deposition of the rocks.)

To the geographer the Paris basin is a conception that stands out clearly and vividly in the mind, but which, like the subject of geography itself, he finds it difficult exactly to define. The nucleus at the centre is a much more definite feature than the vague line of the cell wall. We are aware at once of the vital characteristics of the region—the focusing at the centre of the main feature lines and of the lines of human activity, but in detail the boundary is by no means well defined. For the definition of its borders we must be guided now by one geographical contour, now by another.

The geological features give us a preliminary definition which is very useful. The Paris basin is a region in which the surface rocks are all of a sedimentary character, and most of them belong to periods later than the Liassic. It is bounded by regions in which older rocks predominate: the Armorican Massif to the west, the Central Massif to the south, the Ardennes Massif to the north-east. Northwards the geological boundary of ancient rocks fails, for the sea has invaded the northern part of the

¹ Paul Lemoine: *Géologie du Bassin de Paris*, Paris, 1911, p. 16.

sedimentary basin, while in the east the exposure of Jurassic and older sedimentary rocks continues in regular sequence to the ancient Massifs of the Rhine plateau and the Vosges, forming the plateau of Lorraine, which, from considerations of relief and

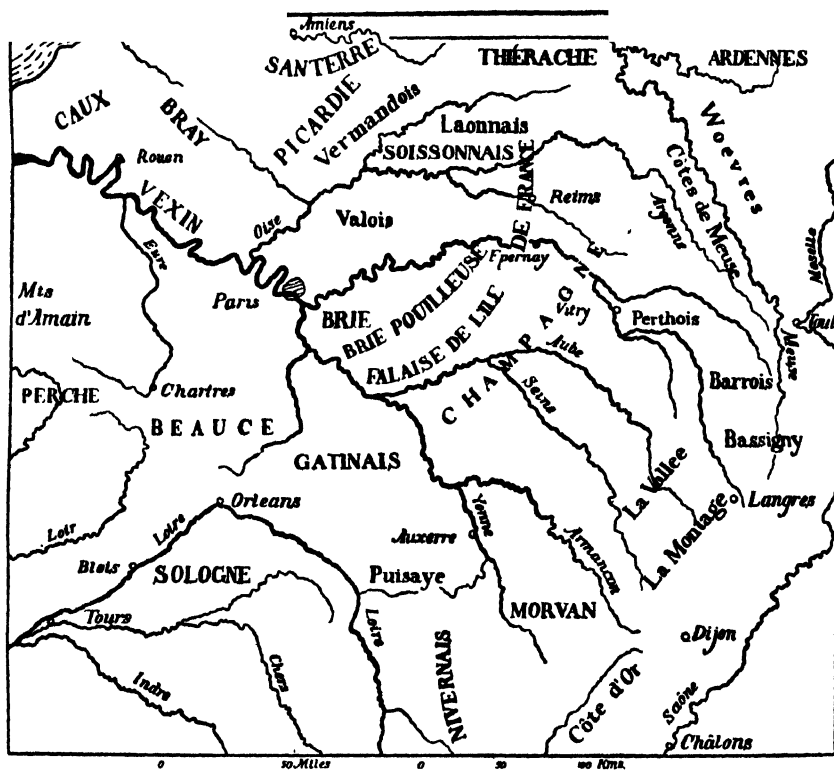


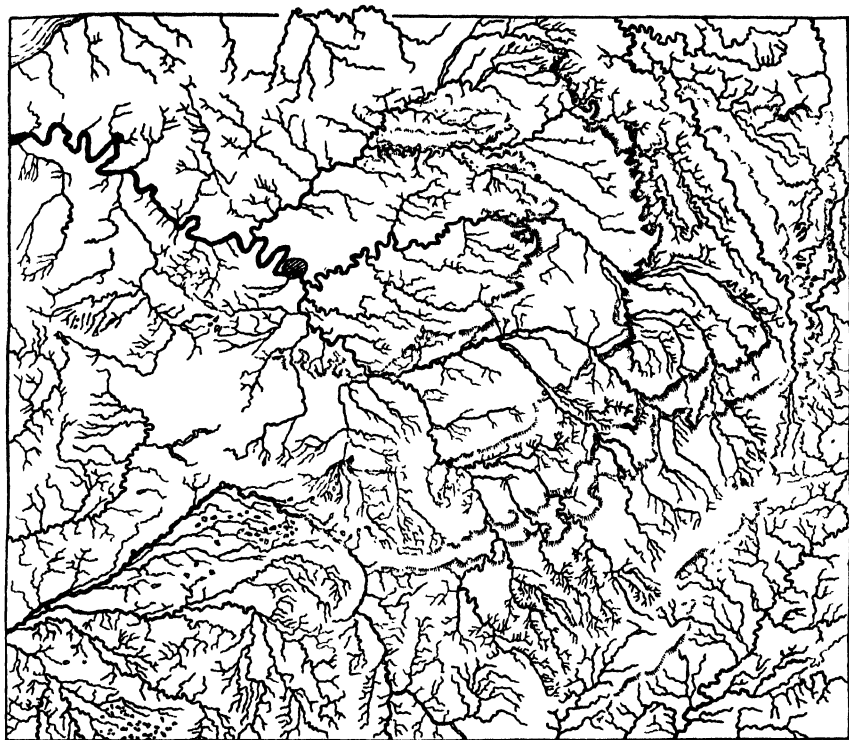
FIG. 21. THE PARIS BASIN. A KEY TO THE HYDROGRAPHICAL MAP OPPOSITE, SHOWING THE MORE IMPORTANT GEOGRAPHICAL DIVISIONS

hydrography and most aspects of human geography, we are fain to regard as forming a distinct region, although the actual boundary is difficult to decide.

Elsewhere the Jurassic limestone rim of the basin in contact with the Hercynian Massifs is broken by a number of broad sills (*seuils*) whereby the waters, in which the sedimentary rocks of the Paris basin were laid down, communicated at various periods with neighbouring seas. In these sills the sedimentary rocks pass over without interruption from the Paris basin into adjoining basins. The sill of Poitou, floored with Jurassic rocks, communicates with the basin of Aquitaine, the sill of Artois, floored with Cretaceous

rocks, opens to the basin of Brussels, the plateau of Langres gives access to the basin of Bresse or the Burgundian basin.

From the point of view of human geography it is chiefly the river development in relation to geological exposures that gives



IG. 22. THE HYDROGRAPHICAL FEATURES OF THE PARIS BASIN. THE READER IS SKED TO CONSIDER THIS MAP CAREFULLY IN CONJUNCTION WITH THE DESCRIPTION IN THE TEXT. IT ILLUSTRATES PROBABLY BETTER THAN MOST OTHER TYPES F MAP THE INTER-RELATION OF ROCK STRUCTURE AND DRAINAGE IN THIS COMPLATED REGION. THE MAJOR LIMESTONE ESCARPMENTS ARE SHOWN BY MEANS F HACHURING. CERTAIN BOLD FEATURES, E.G. THE WATERLESS PLATEAUX OF EAUCE AND CHAMPAGNE, LEAP TO THE EYE BUT THE HYDROGRAPHICAL APILLARIES DISTINGUISH CLEARLY MANY OTHER REGIONS. THE STREAMING ORVAN, WET CHAMPAGNE, THE NARROW ARGONNE VALLEYS, FOR EXAMPLE. THE CONFLICTING TRENDS IN THE DRAINAGE SYSTEM ARE VERY EVIDENT.

the region its character, drawing its component parts together and creating a geographical unit. The main tributaries of the Seine have all cut back into the Jurassic rocks, and some of them into the Trias, and some even into the archæan Massifs, and it is in the Jurassic rocks mainly that the division between the hydrographic

basin of the Seine and of the other great French rivers lies. The Loire is an important exception. Its upper basin forms an intrinsic part of the Central Massif, its lower basin belongs physically to the Armorican Massif; in its middle course it makes an excursion into the sedimentary rocks of the Paris basin. Here it has trenched so wide a vale from east to west and spread so great a mass of detritus as to change the general character and symmetry of the land. So much so that one is in two minds as to whether the Middle Loire area should be treated as belonging to the Paris basin or not. Again, in the north-east, tectonic features have thrown the drainage towards the Channel, away from Paris. The water parting is, however, of such a nature that no barrier is formed from the point of view of human interests or intercourse, nor is there any marked change in soils and subsoils, and one has little hesitation from the point of view of physical geography, in including the Channel margins in a study of the Paris basin. Yet, from the point of view of human geography, relations with the Brussels basin are so close that it seems better to group Picardy and Artois with Flanders in spite of physical contrasts.

Taking into consideration, then, all these factors, it has seemed most fitting to include, in the study of the Paris basin, speaking broadly, the whole of the Seine basin, and to treat as sub-sections the Loire basin between Puisaye and the *bocage* of Anjou, and the Norman coastlands.

THE SEINE BASIN

The basin of the river Seine covers the most complete and well-developed portion—the eastern half—of the geological Paris basin. A study of the Seine basin will therefore cover a research into the characteristic features of soil, settlement, and communications that have combined to make Paris the centre of France.

A comparison of the drainage map with the geological map brings out the fact that the greatest extent and variety of geological exposures in the Paris basin corresponds with the greatest hydrographical development. The Seine and its tributaries occupy a wedge of country with Paris at the apex. The base of this wedge, which lies to the east, measures some 200 miles. The head-waters of the Seine rise chiefly in the Jurassic rocks, and the waters draw together in the centre of the Tertiary basin. Every major tributary of the Seine crosses the series of rocks from the Jurassic to the Tertiary, and it is the differential erosion of the various rocks exposed that gives the variety of landscape characteristic of the basin as a whole.

Limestones of the Jurassic, Cretaceous, and Tertiary periods bulk very largely in the formations of the Paris basin. Sandstones are much less frequently met with, and appear more often than not as recent and surface deposits. Intercalated between the limestones are belts of clay. Erosion has exposed these alternating layers of limestones and clays in alternate concentric bands. The limestones and sandstones, being more or less permeable, usually stand up boldly, forming plateaux, between which the clays are worn down to form a series of vales. The edges of the outcropping limestone have been cut back and form escarpments which face east and south-east, overlooking intervening depressions in the clays.

The main tributaries of the Seine traverse the limestone plateaux in deeply-trenched valleys, cutting them into isolated blocks. Longitudinal streams, drawing their waters from the dip slopes and from the scarped edges of the plateaux, drain the vales. In spite of the variety of plateau and vale thus produced, it must be remembered that the Seine basin covers an area of some 30,000 square miles, about three-quarters of the Paris basin, and that within this region of such marked variety there are a number of sub-regions where the same geographical characteristics cover very wide areas. Some of the plateaux in the Cretaceous belt of upland, for example, exhibit unrelieved monotony.

THE SEINE. Between Flavigny on the Armançon and Langres at the head-waters of the Marne, the Jurassic limestone rim of the Paris basin, which sweeps in a great semi-circle from Hirson, south of the Ardennes, to Châteauroux on the Indre, instead of forming an escarpment overlooking the Lias Clays, as it does to the north and west, arches over and dips down beneath the basin of the Saône. The arch has been disturbed by faulting, so that the dip slope to the south-east is much deeper than that towards Paris and has the appearance of an escarpment.¹ The divide thus formed drains north-west to the Paris basin and south-east to the Saône basin. It lies between 1,300 and 1,600 feet above sea-level and forms a threshold or sill between the Paris and Burgundian depressions. The actual top of the divide is often bare, but the long ridges running down to either basin are, for the most part, well wooded. The Forêt d'Arc, the Forêt de Châtillon, and the Forêt de la Charme slope down to the fertile plains of the Oxford Clay at Châtillon and Montigny at a height of 1,000 feet. On the south-eastern slopes the woods are less extensive and hardly reach below the 1,300-foot contour. The ground slopes more

¹ The upfold of the plateau of Langres is probably superimposed upon a Hercynian anticline which joins the Central Massif to the Vosges via the Monts Faucilles.

steeply ¹ to the south-east than to the north-west, descending in somewhat abrupt terraces to the plain of Burgundy.

It is on the northern spurs of the divide that the river Seine takes its rise. The Seine is only one of four streams that originate here. Its head-waters, together with those of the Ource, the Aube, and the Aujon, fed by springs, form a rake-head of water-courses which rise at varying distances from the heads of dry valleys. In some cases the source of the stream is a marsh at the head of a valley, practically on the water-parting, but the nascent stream soon disappears below ground to emerge again a mile or so down the valley. The Seine emerges, a fully-fledged river, some distance from the head of its valley. Possibly this fact explains why the name of the main river should have been bestowed upon one of its minor head-streams. In dry weather, so permeable is the Oolite, that the Seine, as O. Reclus puts it,² 'is frequently guilty of arriving at Châtillon without a drop of water, or rather of not arriving at all'.

This region of the head-waters of the Seine is known as *La Montagne*—the upland—by the inhabitants, in contradistinction to *La Plaine*—the low-lying zone of country to the west which we shall describe later. The geographers have called it the *plateau de Langres*, because of the dominating position of that ancient fortress, but, as we shall see, Langres and the Marne head-waters do not belong geographically to the Oolitic limestone plateau.

THE OOLITE PLATEAU. The Great Oolite exposure is a zone about ten miles broad. The higher part of the plateau behind the crest is more broken and dissected by valleys than the lower slopes towards Châtillon. This may be explained by the fact that a bed of marl, more or less impermeable, lies near the surface of the plateau below the Great Oolite and is exposed along the slopes of the valleys. This belt of marl holds up the water in the limestone and gives rise to a number of springs as well as to a strip of fertility along the valleys. The position of the villages—a little below the 1,300-foot level on the valley slopes—seems to bear a definite relation to the spring line. The rivers flood in the winter when the water-table in the limestone is high. The lower part of the plateau towards Châtillon is less dissected, the marls lie deeper, and are not exposed, so that in the valleys the water does not come to the surface in so great abundance and the soil is less fertile. As a result the smaller valleys are mainly dry, the villages are few and far between, and, except in the valleys, the land is given up to forest. The rainfall is heavy

¹ On the Carte de l'Etat Majeur 1/200000; No. 34, the north-west illumination of the cartographer tends to exaggerate the impression of a steep descent on the south-east.

² O. Reclus: *Géographie Rapide*, p. 22.

on the plateau, averaging 35 inches. Sheep-rearing for wool, and iron smelting were the early industries of the upland ; both have died down owing to foreign competition in the first place and poor communications in the second.

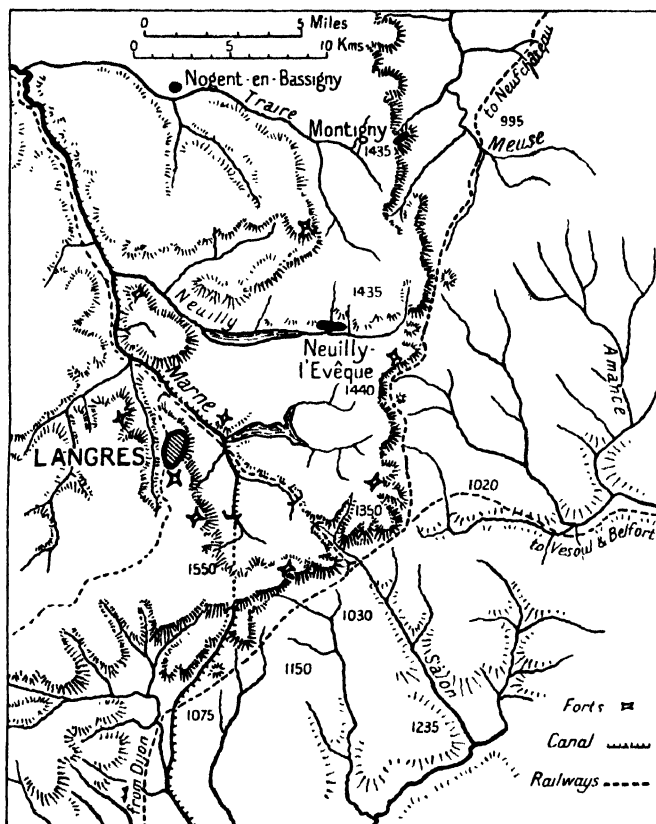


FIG. 23. THE PLATEAU OF LANGRES. THE PLATEAU DROPS STEEPLY TO THE SAÔNE BASIN BY A DOUBLE ESCARPMENT IN THE OOLITIC AND LIASSIC LIMESTONES. BETWEEN THE SCARPS THE LIAS CLAY GIVES RISE TO WATER-LOGGED LANDS. THE FORTRESSES OF LANGRES OCCUPY LIMESTONE BLUFFS. LOCALLY WORKED IRON FOUND AT THE BASE OF THE OOLITE GAVE RISE TO THE CUTLERY INDUSTRY OF NOGENT.

Langres, which has given its name to the whole plateau, lies among the head-waters of the Marne. This river has, in its upper course, a far greater volume than the upper Seine ; its head-streams having cut back through the Oolitic limestone into the wet, impermeable, Upper Lias Clay (Toarcian) beyond.

Langres itself stands on a spur of the Oolitic limestone plateau overlooking the Marne, which flows in a broad valley among the upstanding outliers of yellowish limestone which stud the clay floor.¹ East and south of Langres the ground rises to a water-parting formed by an escarpment of Liassic limestone, which is exposed here owing to lines of faulting. This cliff-like edge has a drop of over 300 feet to the east and south-east. It continues due north past Montigny le Roi, skirting the western edge of the Meuse valley. From the foot of this escarpment a large number of springs break out, supplying streams which drain east to the Amance and south to the Salon, both tributaries of the Saône. So that Langres lies between the escarpment of the Great Oolite and the Liassic limestone escarpment.

The Liassic marls of the Upper Marne district have been eroded, owing to their softness and impermeability, into broad fertile valleys, cutting cirque-fashion into the calcareous plateau to the west of them. The water accumulates on their surface pouring from innumerable springs in the limestone of the plateau. Geographically this pastoral region is a continuation of Bassigny—the upper basin of the Meuse—and is in relation rather with Lorraine than with the Paris basin.

The forts of Langres occupy commanding positions either on the Oolite escarpment or on the hills formed by outliers. They command all the valley routes of the head-waters of the Marne as well as the high-road that leads over the divide to the river Saône and the fortresses of Vesoul and Belfort. Langres is, by its position, attached economically to Dijon and Burgundy rather than to Champagne. Dijon is the market for its dairy produce. Nogent-en-Bassigny imports the raw materials for its cutlery industry from Lorraine. A double-track railway follows the Marne nearly to its source, and then crosses the Lias escarpment by a tunnel nearly a mile long to enter the Saône basin at Chalindrey, where it joins the main line linking Dijon and Vesoul.

South-west of the plateau of Langres, the Armançon has an upper basin closely resembling that of the Marne. Just as the upper Marne, Meuse, and Saône draw their head-waters from the streaming Lias Clays that emerge on the flanks of the ancient Vosges Massif, so the tributaries of the Yonne draw their waters from the Liassic marls that flank the crystalline promontory of Morvan. Alise Ste. Reine occupies a position on the Oze, tributary of the Armançon, very similar to that of Langres above the Marne and of Autun on the Arroux.² Here, on an outlier of Oolitic limestone (the Mont Auxois) a Gallo-Roman stronghold commanded the Roman road from Dijon across the plateau, just

¹ See Fig. 23.

² See Fig. 24.

as Alise commands the railway line from Dijon to Paris via Tonnerre to-day, and the more gently graded national road from Dijon via Vittaux. The Roman ruins above the village of Alise Ste. Reine probably represent the ancient Roman Alesia, where Caesar overcame the Gallic chief Vercingetorix.

The upper tributaries of the Armançon cut through the Lias marl into the crystalline platform beneath, and the upper Serein

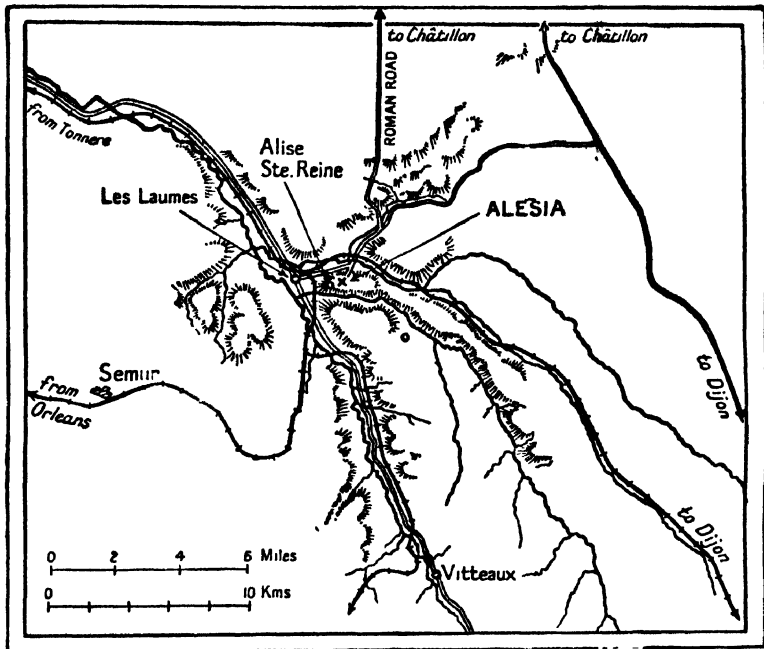


FIG. 24. ALISE STE. REINE, A NODAL POINT OF STRATEGIC IMPORTANCE IN GALLO-ROMAN TIMES, HAS A SIMILAR POSITION TO THAT OF LANGRES.

skirts the very edge of the Morvan Massif. The average altitude of the plateau is in the neighbourhood of 1,400 feet, and the valleys are deeply trenched, with short tributaries entering at right angles. The villages lie, for the most part, at the foot of the valley slopes, just above the broad flood plains in which the streams meander.

In strong contrast to this typical clay country, with its detached mounds and ridges of Oolitic limestone, is the Morvan proper, of which only the extreme northern portion comes under our consideration for the moment, as forming part of the Seine

basin. Here the hardness and impermeability of the archæan rocks, combine with the heavy precipitation resulting from elevation to produce a streaming of surface-water which is highly characteristic. This is more marked on the acid eruptive rocks even than on the granite. On the rounded summits, where there is not much slope, ponds and reservoirs are numerous.

THE YONNE. The largest of the south-eastern tributaries of the Seine, the Yonne rises in a porphyritic mass in the Morvan and drains at first westwards. On emerging from the archæan Massif it turns north and, after having crossed a belt of Lias sands and clays (Bazois), reaches the Oolitic zone surrounding the Morvan Massif only to leave it again at Clamecy.

This portion of the Seine basin is hydrographically important. The Armançon, the Serein, and the upper Yonne, on account of an extensive catchment area, high precipitation, and rapid run-off from the impermeable rocks, collect a very large proportion of the upper water-supply of the Seine, far more than either the upper Seine or the Marne, and send it down with great rapidity to the lower reaches. They have therefore a marked effect on the régime of the main stream.

The northern Morvan is not thickly peopled. Most of the surface is forested, and timber formed until recently an important article of export. It was cut into logs and floated down the streams to certain collecting centres—Clamecy and Vermenton or Coulanges—whence the *péniches* carried it down the canalized Yonne and Seine to Paris for fuel. The industry has declined owing to the shortage, and rise in cost, of labour. The wood is now, to a large extent, hauled by tractors from the forests to the chemical works of Clamecy and Prémency, or is exported by Swiss merchants on light railways.¹

Saulieu, lying on the water-parting between the headwaters of the Yonne and Arroux, is the focusing point of half a dozen converging first-class roads—a comment on the part that is played as a barrier by the jutting promontory of the Morvan.²

We see that the Seine is engaged in trespassing by its headwaters Yonne and Marne beyond the Oolitic limestone rim of its basin into the Lias Clays and marls of Burgundy and Lorraine on the one hand, and into the ancient crystalline Massif of the Morvan on the other, and it must be remembered that these excursions have a definite effect on the régime of the main river, as well as being important, in that they provide routes linking the basin of Paris with the upper Loire and the Saône and Rhône.

¹ M. L. Arviset : ' Le flottage à Bûches perdues dans le Morvan ' (*A. de G.*, 1924, p. 579). See Chap. XIV, on Waterways, p. 491.

² See Chap. II, p. 72.

We see, also, that the various geological exposures of rock have given rise to regions of marked contrast : first we have La Montagne (the Plateau de Langres) which forms the sill leading from the Paris basin to the Saône depression (or basin of Upper Burgundy), and consists of rolling country, 1,300 to 1,600 feet high, heavily wooded with beech, oak, and ash, very permeable, with deeply trenched, often dry valleys—a land of springs and underground waters with a population clinging to the valley slopes, except for that small section of it that tends the flocks of sheep on the plateau.¹ Secondly, to the north-east, Bassigny, where the Marne has cut back into the soft Lias Clays giving easy passage to routes from the Paris basin to Upper Burgundy and Lorraine, the limestone butts overlooking the clay plain providing the natural conditions necessary for a Roman *oppidum* or a modern strong point. South-west of La Montagne we have Auxois to balance Bassigny, with Alise Ste. Reine to counter-balance Langres, dominating three valley-ways, but unfortified to-day, because the routes controlled do not lead out of France. Thirdly, the Morvan upland, with its streaming waters, its peat bogs and lakes, its pasture and forest, in strong contrast to the more fertile zone of mixed soils that lies around it, is completed in the west by Bazois among the head-waters of the Yonne. The feature which links these otherwise diverse regions is the convergence of the valley-ways of the Seine.

THE OXFORD CLAY VALE

On leaving the Oolitic limestone, the rivers we have been considering pass into a narrow belt of Oxford Clay, beyond which lies a zone about six miles wide of Corallian limestone. On the Oxford Clay the valleys widen. The rivers collect large quantities of surface-water from the edge of the Corallian limestone. Each river has cut a broad re-entrant into the face of the Corallian rocks. The Oxford Clay belt, narrow as it is, stands out in marked contrast to the wooded limestone heights on either side of it. Its average height is some 700 feet above sea-level, the limestone uplands on either side having an average level of 1,150 feet. Ponds and lakes are numerous and the streams often form a network of water-courses. The villages are also numerous, in marked contrast to conditions on the uplands, but avoid the river banks, clinging to the lower fertile slopes of the Corallian edge. Water is plentiful. Here we no longer come across such

¹ The pasturing of sheep is giving way, under the modern system of applying artificial fertilizers, to cereals, even on the plateau, and to the rearing of milch cattle.

place-names as Ampilly-le-Sec, Fontaine-les-Sèches, Coulmiers-le-Sec, Puits, which occur on the limestone. This broad belt of plain is known as *La Vallée* or *Le Pays Bas*, in contradistinction to *La Montagne*—the limestone plateau to the east. It is good agricultural land, producing cereals and beet. A first-class road and double-track railway make use of the Vallée to unite Chaumont-en-Bassigny to Nuit-sous-Ravières-sur-Armançon and link up the towns and villages that mark the outlets of the valley passages through the Corallian escarpment.¹

THE CORALLIAN PLATEAU. The Corallian limestone, like that of the Great Oolite, is very dry and permeable. The water-courses show little development, and the formation contains no intercalated bed of marl to hold the water to the surface and widen the valleys, as in the case of the Oolite plateau. For the same reason the valleys are straight-sided and do not show the gradual slopes of marl surmounted by cliffs of limestone which is so marked a feature of the valleys, in the Oolite. The rivers have now gained volume and strength, and they make their way across the Corallian plateau in steep-sided, flat-bottomed, meandering trenches. Tributary streams are very few, but dry valleys wind back from the main valleys far into the plateau, which is heavily wooded, especially in the east, because the land is infertile, on account of the poor soils and heavy rainfall. The forest of Clairvaux covers more than 10,000 acres. The timber of the forests makes up to a certain extent for the lack of fertility of the uplands. The Corallian limestone furnishes an excellent building-stone, which gives the farm-houses and cottages an air of solidity and prosperity which is in contrast with the general unproductiveness of the region. The Corallian plateau, in addition to its timber, produces also a small quantity of iron.

Although the main zone of Corallian limestone runs from south-west to north-east between the Marne and Yonne, the formation is represented also in the upper basin of the Aisne.

THE KIMERIDGE CLAY VALE. The Corallian dips down beneath the Kimeridge Clays and marls, which form a belt of lowland very similar to that formed by the Oxford Clay. This zone is called in the north-east *Le Barrois* and in the south-east *Le Tonnerrois*. Whereas the market towns of the Oxford Clay belt—Chaumont-en-Bassigny and Châtillon-sur-Seine—occur on the rivers just before they leave the dip slope of the Oolitic limestone, those of the Kimeridge Clay avoid the dip slope of the

¹ These are Audelot on the Rognon; Bologne, where the Marne cuts into the Corallian; Bricon, whence the line passes to Vitry-le-François; Troyes, Montigny-sur-Aube, Brion-sur-Ouche, Châtillon-sur-Seine, Laignes on the Laignes, Nuits-sous-Ravières-sur-Armançon, Noyers on the Serein, and Vermenton on the Yonne.

Corallian and lie well within the angles that the rivers have cut into the succeeding zone—that of the Portland limestone. Auxerre and Tonnerre, Bar-sur-Seine, Bar-sur-Aube, and Bar-le-Duc control the valleys which lead from the long, fertile belt of Kimeridge Clay country north-eastwards through the Portland plateau. In every instance a spur of upland jutting into the valley provided the strategic position for a fortress, but these towns to-day reach down to the river bank and the bridge, unlike the villages, which avoid the flat, damp valleys. The pastures of the valley-bottoms feed large numbers of cattle, which fact has led to the preparation of skins and hides and the tanning and strap-making industry of Bar-sur-Aube and Bar-sur-Seine. In the valleys converging on Bar-sur-Seine and Bar-sur-Aube a recognized champagne wine is produced.¹

THE PORTLAND PLATEAU. Once more the rivers, leaving the narrow belt of clay lowlands, make their way across a limestone plateau—the Portland limestone. This plateau narrows to one and a half to two miles in the south, but broadens northward to some nine miles. Owing either to the possibility of obtaining water from springs and wells, or to the presence of patches of Neocomian marls overlying the limestone, the uplands here are fairly well peopled, and contrast with the Oolitic and Corallian exposures. But the higher parts rise to some 1,000 feet and are uninhabited.

The rivers, after traversing the Portland uplands in deeply trenched valleys, now leave the Jurassic series of rocks and enter the lowest series of the Cretaceous system (Neocomian). These are ushered in by a narrow belt of sands alternating with clays which are only slightly permeable, and their fertility is testified to by the large number of villages. This zone is, however, not continuous.

LA CHAMPAGNE HUMIDE—THE GAULT. The Neocomian belt, where it exists, passes gradually into the wet lands of the *Gault Clay* (Albien). Except for the alluvial strips and patches along the river valleys, which here are wide and shallow, the Gault carries a very small population. Forest, lake, and swamp cover most of the area and the villages are almost confined to the alluvium which the rivers, checked in their flow by the level nature of the plain and the breadth of their channels, have deposited in huge patches along their courses. The fertility of these well-watered, limy, alluvial patches is shown by great density of population. Troyes, Brienne-le-Château, Vitry-le-François are flourishing market centres of these islands of fertility. This region is known as *La Champagne humide* to

¹ See p. 421.

distinguish it from La Champagne *Pouilleuse*, which we shall describe below. The exposure of intercalated sands gives a certain variety of relief, but the elevation everywhere is very slight. The woodland, of which there are remnants even in the cultivated areas, is largely of willow, but heath-plants such as broom and gorse cover the more sandy regions. The forest of Der, which accompanies the river Blaize for twenty miles, has oak trees which are much in demand for furniture-making at St. Dizier and at other places. The clays of La Champagne *humide* are used locally for brick-making. After the Franco-Prussian War manufacturers from Lorraine set up ornamental tile-works and works for making sanitary fittings. There are several such works in the neighbourhood of Vitry-le-François.

The real life of the land is in the fertile alluvial valleys. Even the swamps and moors of the Gault Clay have been to a certain extent drained and cleared and brought under the plough, but the alluvial stretches have been cultivated from the earliest times. Almost every kind of cereal is grown. *Perthois*, the broad alluvial expanse built up by the Marne and its tributaries the Saulx and the Blaize, that drain the gentle western slopes of the Portland limestone upland, is the largest and most prosperous of these plains of mixed alluvium. The ferruginous clays of *La Champagne humide* gave rise to an iron industry in early days on both sides of the Blaize, in the Forêt de Der and near le Val and at Cousances-aux-Forges, east of the Marne. Wassy is an instance of an old 'hammer', once a flour mill. St. Dizier is the chief centre of the metallurgical district of the upper Marne, which includes, also, Bar-le-Duc, Cousances-aux-Forges, Wassy on the Blaize, Sommevoire, Rouvroy on the Marne, and Vitry-le-François, and which is related industrially to Lorraine whence pig-iron and steel blooms are imported to be worked up, local ore being only used to be mixed with that imported.

Hitherto we have been following the Seine and its tributaries across the rim of the Paris basin. With the broad belt of Gault Clay we have now reached the floor of the basin. The winter climate is less raw, the rainfall diminishes with the decreased altitude. Life expands as the density of population increases in its convergence upon Paris at the centre. As we leave the Jurassic upland the colour-impression changes too—becomes warmer in tone and more varied. The houses of brick and timber contrast with the bleak, solid-looking stone buildings of the limestone plateaux.

THE CHALK. The fourth of the concentric zones of limestone upland that go to make up the geological structure of the Paris basin is far more extensive than the three already mentioned, and,

although the elevation offers nothing striking, the breadth of the exposure, the thickness and homogeneity and permeability of the chalk of which it is composed gives it a character that divides it sharply from all the other limestone formations of the basin.

All the eastern tributaries of the Seine cut across this zone. The basin of the Yonne, however, differs from the others. Whereas the Seine, Aube, Marne, Aisne, and Oise cut through bare chalk downs, the Yonne and its tributary, the Loing, pass through chalk uplands, which are thickly covered with impermeable clays, as in *Gâtinais*, or with clays and sands as in the *Forêt d'Othe*. These coverings of the chalk are really extensive. They are probably outliers of the Tertiary system which occupies the centre of the Paris basin. The characteristic features of *Gâtinais* resemble those of the chalk downs farther north in the contours of the valley slopes. The clay soil is generally cold and only rendered fertile by much labour. Whatever its origin, the completeness of this sheet of impermeable substance has reproduced on the surface of the plateau many of the features of the Gault lowland. In spite of reclamation, shallow lakes and bogs still cover large areas, and much of the surface is given up to woods and forests. The wet heathland, with practically no run-off, used to be almost submerged in winter. Much of this moor, however, can now be used for agriculture, and the *gâtines*, as the sheets of shallow water are called, are gradually disappearing. In spite of the impermeability of the clays, so level is the surface that the run-off into the streams is slow and the rivers do not rise rapidly, as do those of the Gault and the heavy Lias Clay. Villages are small and scattered over the plateau. The valley slopes are the only regions of marked productivity, for here the chalk and, more important, the chalk marl are exposed.

Montargis, the centre of *Gâtinais*, lies at the junction of a number of streams and of the Briare canal, which links it with Briare on the Loire. It has tanneries and rubber and chemical factories. The little river Betz bounds *Gâtinais* on the north. Beyond this stream, between it and the Yonne, the clay is intercalated with bands of sand, and the character of the country changes accordingly. The soils are lighter and warmer, and this change in geological conditions is reflected in the increased number of villages. The *Gâtinais* area is drained by the River Loing. A low divide, for the most part less than 650 feet above sea-level, separates the head-streams of this tributary of the Seine from the river Loire. The divide is studded with lakes like the rest of the plateau, but a large part of it is occupied by the great *Forêt d'Orléans*, which has survived owing to the infertility of its sandy soils.

If we now follow the arc of the chalk plateau round in an easterly direction, we come next to the *Pays d'Othe*. Here the escarpment of the chalk rises abruptly above the narrow zone of the Gault Clay, and the plateau dips gently north-eastward to the valley of the river Vanne and beyond that valley to the Seine. The dip slope between the escarpment and the valley of the Vanne has retained, as in Gâtinais, a relic of the Tertiary sea in the form of a layer of sandy clays (*argiles plastiques*). This formation is semi-permeable. Deeply-trenched valleys are numerous, but watercourses are often intermittent and sometimes dry valleys occur. The soils are very light, and a large area is given up to forest in consequence. The Forêt d'Othe stretches along the highest part of the plateau behind the escarpment for some twenty miles and extends down the spurs of the dip slope. The villages lie in the valleys between the wooded spurs. The valley of the Vanne, a longitudinal stream which appears to follow a line of weakness in the chalk parallel to the escarpment, drains a number of tributary valleys, generally dry, from the Forêt d'Othe, as also does the Yonne. The Vanne is fed almost entirely by springs along the valley and in the side valleys. These springs and wells in the tributary valleys are tapped by two great aqueducts, which are carried along the valleys of the main rivers, the Yonne and Vanne, unite near Sens, and are then carried over the plateaux with a very gentle gradient, via the Forest of Fontainebleau, to Paris, forming one of the most important sources of water for the capital. This artificial river is known as the Vanne Aqueduct. It crosses the river Yonne about five miles below Sens.

Strictly speaking, the Pays d'Othe is the region comprising the forest, the chalk escarpment to the south-east of it, and the strip of chalk marl at the foot, which follows the longitudinal valley of the Armançon. It thus includes forest and pasture, water output, ploughland, and water-meadow—an arrangement that reminds one of the parish strips on the South Downs. It is on the chalk marl that cultivation is chiefly carried on, but sugar-beet and most cereals are grown on the lower plateau, too, and champagne vines are cultivated on the slopes. The Pays d'Othe is noted for its cider-apples. Bussy-en-Othe, Paroy-en-Othe, Nogent-en-Othe, Maray-en-Othe, and other place-names with the same termination occur in the valleys of the streams draining from the forest to the Armançon and to the Vanne. Aix-en-Othe, as the name might imply, was once the site of Gallo-Roman baths. To-day it is one of the minor centres of the hosiery manufacture, satellite to Troyes. The ferruginous sands beneath the forest used to be worked, as such

names as Les Minières, Rigny-le-Ferron, La Forge à l'Eau, testify.

North-west of the Vanne the chalk plateau continues to slope gently towards the Tertiary rocks of the centre of the Paris basin. It forms an oblong tract of plateau country, bounded on the west and east by the consequent courses of the Yonne and Seine respectively, in the south by the high-level valley of the Vanne, and in the north by the Seine again, which, at Romilly-sur-Seine becomes a longitudinal stream and hugs the foot of the Tertiary escarpment. Sens, at the junction of Vanne and Yonne, is the market centre of the cultivated portion of this upland. Patches of Tertiary sands and clays still cling to the higher parts of the plateau, but in the east and north the bare chalk is exposed. Here surface water disappears almost entirely. The population, instead of living in scattered farms and hamlets, is gathered into large villages, because the increasing depth at which water can be found necessitates communal well-sinking or the communal use of a spring. The names Fontaine, Fontenay, Somme-Fontaine (*Somme* means a spring) occur, and the name Origny-le-Sec is significant.

CHAMPAGNE POUILLEUSE. When we cross the consequent Seine north-eastwards we find ourselves in the middle of the typical Champagne country—Dry Champagne, or *La Champagne Pouilleuse*. In England Salisbury Plain approaches it most nearly in barrenness, in desolateness, in the windswept horizons, in the interminable straightness of the hedgeless roads, in the utter lack of streams or ponds to gladden the eye.

East of the Seine the chalk escarpment is an insignificant feature, barely distinguishable on the land or on the map. Yet the contrast is great between the low chalk plateau and the water-logged plains of the Gault—between *Champagne pouilleuse* and *Champagne humide*. The bare chalk of Champagne stretches in a curving zone forty miles wide for over a hundred miles. Woods are small, few, and scattered, so that the nakedness of the chalk plateaux is in strong contrast to the wooded uplands of the other three limestone zones we have traversed and to the Gault plain. The water-supply is once more the controlling factor in the distribution of population. Only where a depression in the plateau brings the water-table near enough to the surface to be reached without artesian borings, or where it actually comes to the surface on the slopes of a valley so that the water puts out in springs, do we find human settlement. The village names are significant enough—Sompuis, Somsois, Somme-suipe, Somme-sous, Fontaine-Luyères.

The life of Champagne is concentrated in the main valleys of

the Seine and its tributary the Aube, as from Gallic times it has been. The departmental boundary between Aube and Marne follows the height of land between these two rivers. This was also the frontier between the ancient bishoprics of Reims and Sens and earlier between the Gallic tribes of the Runi and the Tricassi. Somewhere on this desolate plateau, near the strategic centre of Troyes, probably between Aube and Seine, was fought the famous battle that stemmed the advance of Attila and his Huns, where 'the nations from the Volga to the Atlantic were assembled'. Gibbon suggests that the selection of the bare chalk downs by Attila was on account of the smooth and level surface adapted to the operations of his Scythian cavalry.¹

The rivers, as they flow through the permeable chalk, receive a regular but gentle supply from the springs that open on the slopes of their valleys. Owing to the flocculation caused by the lime in solution, the water is very clear, and such small amount of detritus as is washed down from the upland is quickly deposited. The rivers have therefore very little scouring capacity. They meander quietly over the broad valley bottom that their ancient forerunners carved out for them, forming a network of backwaters, ox-bows, and cut-offs. The level of the valley floor is slowly but steadily being raised by the growth of peat. The flat, often swampy, surface can at best be used for pasturage. On either side of the valley, however, between the water-meadows and the steep chalk slopes, lies a narrow belt of arable land. Between the meadow and the ploughed fields lie the villages stretched out along the road that follows the valley, so that there is frequently a continuous line of dwellings between one village and another. Following the river run the canal and local roads linking village with village on either side of the valley, at a slightly higher level the railroad, and above that again the main trunk road, leading from Troyes to Paris via Nogent-sur-Seine and Melun.

The Aube valley shows the same distribution of villages and hamlets as we find in that of the Seine, but the main road and railway cross the valley to link up Troyes and Châlons-sur-Marne.

The town of *Troyes* lies at the entrance of the Seine valley into the chalk plateau. Its natural nodality, for it lies on the most direct route between the Rhine and Paris, as well as on the road that follows the chalk marl outcrop at the foot of the chalk plateau, together with the great fertility induced by the outcrop of this same chalk marl and the added riches of the alluvium deposited by the voluminous waters from the Gault, early made

¹ Gibbon: *Decline and Fall of the Roman Empire*, edited by J. B. Bury, Vol. III, Appendix 28, p. 507.

Troyes a centre of importance. It was the capital of the Celtic tribe of the Tricassi. If we add to these natural advantages the importance of its strategic position, controlling routes from Rhine and Rhône on the one hand and Reims and Paris on the other, we understand why it should have become the Roman Augustobona, why it should have suffered attack by the Huns, the Normans, and the English, why it should have been sacked by the Emperor Charles the Fifth, and, to come down to more modern times, why the town should have been the centre of the French campaign of the Allies against Napoleon in 1814. Its nodality made it the site of a famous fair held in rotation with Arcis-sur-Aube, Lagny, and Provins, to which came the merchants of Paris, Burgundy, Flanders, and Lorraine. The sheep-farming, which was and is still the main resource of the arid chalk plateau, early gave rise to a textile industry which flourished especially among the Protestants of Troyes. The repeal of the Edict of Nantes, however, was disastrous to the prosperity of the town, reducing its population from 50,000 to 12,000. The town still maintains a textile industry, specializing in hosiery. It manufactures cottons, woollens, and wool, artificial silk, silk, and schappe. Modern developments include light engineering, attracted by excellent communications and stimulated latterly by the devastation of the north-east of France. Such are motor-works, and the making of hosiery machinery, which before the War was imported from Germany, and which supplies the hosiery industry which has developed in the Aube basin, as at Romilly-sur-Seine, Aix-en-Othe, Arcis-sur-Aube. Cottage hosiery machines work all over the department for the large factories, using gas, petrol, or electric power. Dyeing is complementary to the textile industry. The fact that Troyes is at the junction of seven important railway lines and many more motor-roads, to say nothing of a navigable waterway, has preserved its importance as a market town with a population of about 56,750.

To-day *Champagne pouilleuse* does not offer quite so desolate an aspect as it did fifty years ago. Afforestation is gradually clothing the bare downs with plantations of pine and the marshy bottoms with alders and willows, and artificial fertilizer is enriching the thin soil of the plateau.

If now, starting from the Aube, we follow the bare chalk uplands of Champagne northwards and north-eastwards, we find ourselves, after crossing a flat and indeterminate water-parting, in the basin of the Marne. We have already traced the course of this river from the Lias Clay basin of Langres across the limestone plateaux that lie outside the chalk zone. We have noted the great expansion of the zone of Gault Clay through

which the river passes and the enormous masses of alluvium that, at an earlier period, its streams deposited to form the fertile farm-lands of Perthois in the neighbourhood of Vitry-le-François. The character of the chalk plateau varies hardly at all as we cross from the Seine to the Marne valley. Sheep-rearing is the main occupation, now as in the Middle Ages, and woollens are still manufactured in the district, though we no longer hear of the once famous *shalloons*, or cloth of Châlons. Here, too, afforestation has for some time past been reclaiming the upland and restricting the dreary wastes. The military manœuvre grounds, known as the Camp de Châlons, established by Napoleon in 1857, still covers some 30,000 acres of bare chalk. Hard by, and close to the little village of La Cheppe, is the reputed site of the famous battle of Mauriac, traditionally known as the 'battle of Châlons'.¹

Châlons, unlike the other *ceinture* towns that guard the routes leading to the centre of the Paris basin, lies, not at a break in the escarpment wall, but in the middle of the chalk plains where the Marne cuts its steep-sided flat-bottomed valley, half-way between Vitry and Epernay. The high-road to Strasbourg follows the brink of the valley on the east. Half-way down the slope the local road winds between village and village, below that again runs the Marne lateral canal, while the Marne itself winds at the bottom, in its marshy flood-plain. The Roman road avoids the valley and cuts straight as a die across the plateau from south to north, but neither this ancient way nor the modern chaussées, that rival it in straightness, have been able to induce important settlement on the plateau. Arcis marks the crossing of the Aube, but the intersection of the great trunk roads Toul-Paris and Châlons-Troyes is marked only by the village of Somme-sous.

Early lines of movement, keeping to the open upland, connected Châlons with Reims rather than with Paris. When the Roman roads decayed and water-transport had to be used, Châlons found itself on an important navigable route leading from Burgundy or Lorraine to Paris. The convergence of the plateau roads to cross the river accounts for the development of the town in such an unusual site. Châlons is one of the three main centres of viticulture and of the manufacture of Champagne wine. The south-east facing slopes of the valleys, and the warmth of the chalk soil are favourable to the cultivation of the small, sweet grape from which champagne is made. The soft chalk rock has been excavated to form miles of galleries, some of which were probably Roman quarry-workings. Here the

¹ But see footnote p. 120.

depth is sufficient to ensure an even temperature throughout the year, suitable for the storing and preparation of the wine. But the making of champagne is carried on now chiefly on the edge of the Tertiary escarpment, round Reims and Epernay, and the cellars are now used for storing beer, whose manufacture in this district indicates a link with the traditions of Lorraine.

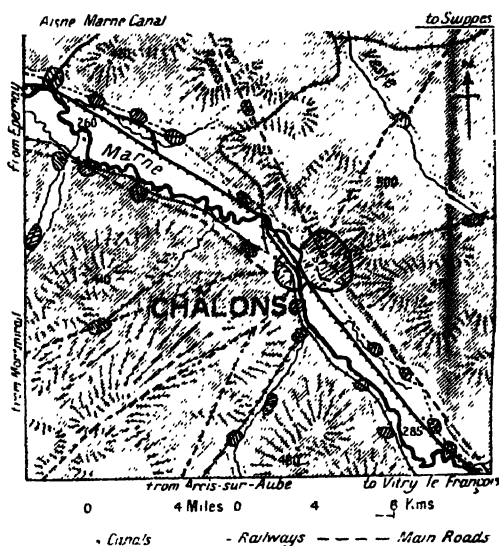


FIG. 25. CHÂLONS-SUR-MARNE, A BRIDGE TOWN, WHERE THE PLATEAU ROADS CONVERGE TO CROSS THE MARNE. NOTE THE TYPICAL TRENCHED VALLEY AND THE ROADS, RAILWAYS AND VILLAGES AVOIDING THE FLAT, MARSHY VALLEY FLOOR.

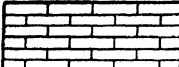
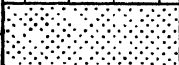



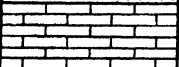
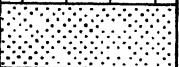
THE TERTIARY MASSIF. It is only north of Beauce that the Tertiary Massif stands with a steep escarpment overlooking the lower slopes of the chalk plain. From the junction of Seine and Loing this escarpment stretches in a great semi-circle via Provins, Sézanne, Epernay, Reims, and Lâon to Lafère. The Seine, from the neighbourhood of Romilly, flows at the foot of the escarpment to the neighbourhood of Fontainebleau, where it resumes its consequent flow at the junction of the Loing. About forty miles to the north the Marne flows, between Epernay and Paris, roughly parallel with this subsequent reach of the Seine, cutting a broad passage-way for itself right across the Tertiary mass. Farther north still the Aisne and then the Oise also flow parallel

to the subsequent Seine, dividing the northern section of the Tertiary block into narrow east-west ridges.

BEAUCE. Let us now return to the southern section of the Tertiary plateau, where the Tertiary escarpment is lacking. We have seen how in Gâtinais the Upper Tertiary rocks spread southwards, covering and overlapping the chalk deposits of the Secondary period. West of the Loing and north of its tributary the Fusain, following, practically without interruption, the gentle slope towards the centre of the Paris basin, we pass from Gâtinais into Beauce, from a clay plateau, covered with surface streams, to a limestone plateau of great permeability. As regards relief, this plateau differs scarcely at all from either Gâtinais or *Champagne pouilleuse*. Like the latter it has but little surface water. Its rivers are few. Even the valleys are scarce and such as exist are, for the most part, dry. Beauce has, however, one saving characteristic which distinguishes it from *Champagne pouilleuse*. Over large patches of the monotonous plateau lies a covering of loam, thin, it is true, but capable of retaining a sufficient quantity of rain on the surface to nourish crops. Beauce is one of the most important wheat regions of France. It is an island of fertility encircled by forest. The wooded Gâtinais extends south of it to the great *Forêt d'Orléans*; to the north, wherever erosion has laid bare the *Sables de Fontainebleau*, forest occupies all the valley slopes. The great thicknesses of the lacustrine limestone, or *Calcaire de Beauce*, makes the sinking of wells a costly affair. As a result we find the population of the plateau grouped in villages of considerable size, or in large farms which are scattered over the surface of the plateau. Gâtinais and Beauce, then, stand in sharp contrast to one another. Beauce is part of the Tertiary block itself, whereas Gâtinais belongs, as to its substructure, to the Secondary system, and has but a thin outlier of Tertiary clays as covering, albeit this makes all the difference between a dry chalk plateau and a land of marsh, lake, and forest.

BRIE. East and north of Beauce, on the other side of the Seine, the *Calcaire de Beauce*, together with the *Sables de Fontainebleau* which underlie it, has disappeared, and we find ourselves on a plateau similar in height to that of Beauce and Gâtinais, though sloping gently towards Paris, and composed of Brie limestone. Although both uplands are composed of limestone, Brie is as plentifully supplied with water as Beauce is dry. The reason is to be found in the geological structure (Fig. 26). Whereas the Beauce limestone as well as the Fontainebleau sands, both porous rocks, must be penetrated before the water table held up by the *Marnes à huitres* is reached, in the case of Brie, only

relatively thin layers of *Calcaire de Brie* lie above the water-holding strata of the marls. Moreover, the decalcified upper layers of Brie limestone, known as *meulères*, are covered thickly with residual clay. So level is the plateau that when the surveyors were tracing the course of the Vanne Aqueduct they were obliged to make a divergence of half a mile to find a difference of level of three feet. In parts, especially northwards near the Tertiary escarpment, the limestone gives place to *argiles vertes*, a

Lithological Characters	Dominant beds	Older French Terminology
 Limestone and 'meulères' (hard, light, siliceous building stone)	Calcaire de Beauce	Aquitainen and Chattien
 Sands and sandstones	Sables de Fontainebleau	Stampien
 Marls and 'meulères'	Calcaire de Brie	Sannoisien
 Marls, limestone and gypsum	Calcaire de St Ouen	Bartonien
 Sands	Sables de Beauchamp	Ledien
 Hard, coarse limestone	Calcaire grossier	Lutitien
 Sands, clays and lignites	Sables de Bracheux	Yprésien and Sparnacien
C H A L K		

Note : For Lutitien read Lutétien. To Yprésien and Sparnacien add Thanétien.

(Sparnacien plus Thanétien = Landénien)

FIG. 26. A TABULAR SUMMARY OF THE MORE IMPORTANT TERTIARY ROCK FORMATIONS EXPOSED IN THE PARIS BASIN

very impermeable rock. This, the higher portion of the plateau, must at one time have been densely forested, and in places its wet, level surface must have resembled Gâtinais. To-day the once waterlogged area has been, for the most part, reclaimed by systematic drainage. Like Beauce, Brie is blessed with a covering of *limon*, the presence of which has made the laborious draining of the country worth while. Whereas, therefore, in Beauce water is difficult to come by and the rivers are few, in Brie there is a well-developed stream system, and water can be procured anywhere without incurring the expense of sinking deep wells ; so

that large villages give place to scattered farms and homesteads and the cultivation of grain and sugar-beet is varied by fruit and dairy-farming and cattle and sheep rearing. Brie butter and cheese are famous. Along the valleys the *argiles vertes* are exposed, announcing their presence by a line of poplars. The Grand and Petit Morin are typical of the verdant valleys of Brie.

The old market town of Melun, on the P.L.M. line between Paris and Fontainebleau, is the capital of Brie to-day, or rather of the department of Seine et Marne. Formerly Provins, east of Melun, was the capital of the *pays*. It lies just at the foot of the Tertiary escarpment. To-day its population numbers only about 7,500 against the 15,589 of Melun, but its fortifications and twelfth-century tower are evidence of its one-time importance. Its roses, once famous, are now grown mainly for making *confitures* or are preserved for decorating chocolates.

Here at Provins and northwards through Epernay and Reims, the *argile plastique* at the base of the Tertiary rocks surmounts the chalk in the escarpment overlooking Champagne. Numbers of springs rise in this clay, among them the source of the Voulzie, made famous by Hégisippe Moreau.

If we follow the cliff that separates Champagne from Brie, we come to the point where the river Marne, now a broad and voluminous stream, enters the Tertiary Massif at Epernay. It flows at first between high cliffs of *calcaire grossière*, travertine, and gypsum, but as these layers dip towards the centre of the Paris basin the *argiles vertes* appear on the surface and, as we proceed farther downstream, these are capped by the *Calcaires de Brie*, and appear only as a narrow ribbon of impermeable rock sandwiched between the exposed limestones of the valley slope.

Epernay is the second of the great wine centres of Champagne (Reims being the first). It stands on the left bank of the Marne on a southwards facing spur of the Tertiary escarpment where the chalk forms the lower slopes of Mont Bernon. Excavated in the chalk on which the town is built are labyrinthine galleries, said to be in part made by the Romans and used to-day, as at Reims, for the storage of champagne in the course of bottling. The *argile plastique* which separates the chalk from the *calcaire grossière* in the Tertiary escarpment provides the raw material for a coarse earthenware which is made at Epernay.

TARDENOIS. The Marne forms a dividing line between two very different types of country within the Tertiary Massif of the Paris basin. The rocks of the Tertiary basin dip towards Paris, it is true, but they also dip southwards. The greater elevation of the plateau to the north has led to a greater erosion, with the result that as you travel across the plateau from south to north

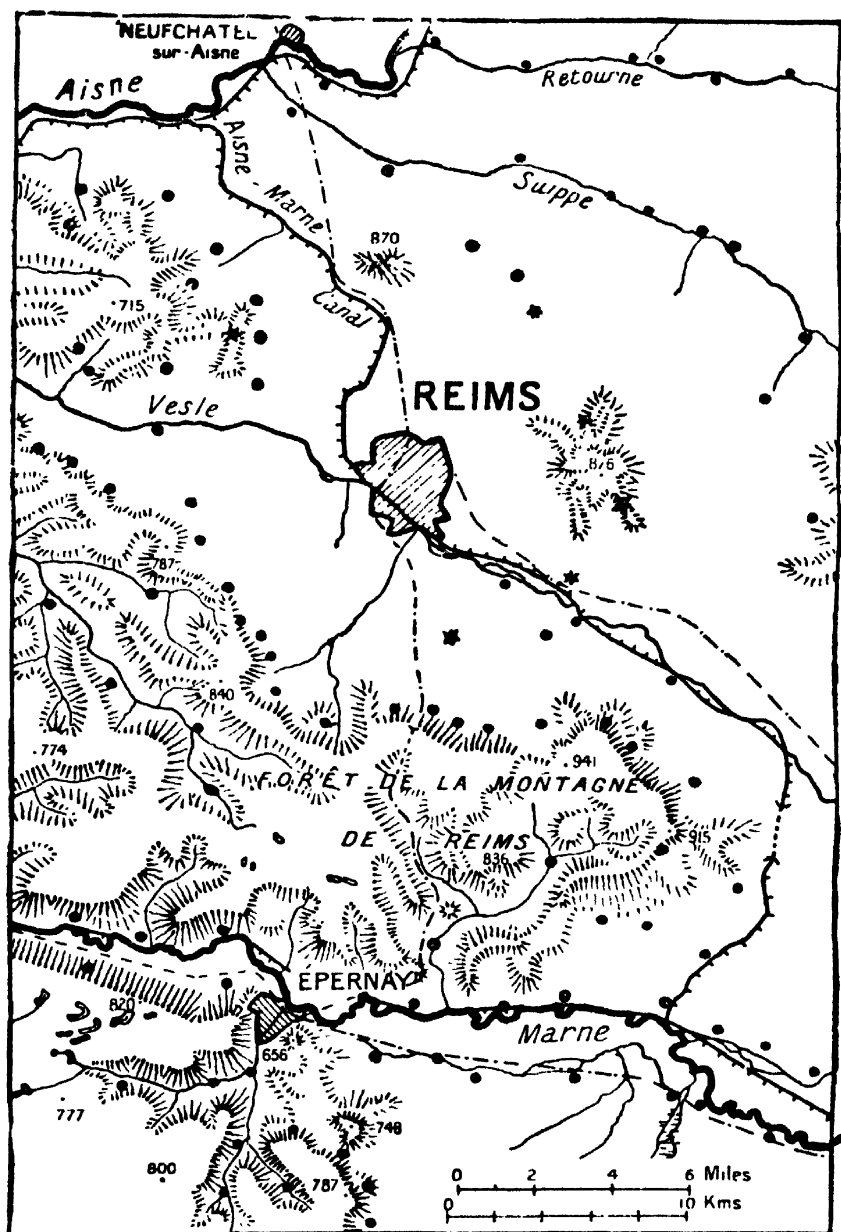


FIG. 27. TO SHOW THE POSITION OF REIMS AND EPERNAY AT THE FOOT OF THE TERTIARY ESCARPMENT. LIMESTONE SPURS AND OUTLIERS AFFORD SITES FOR FORTIFICATIONS. NOTE THE POSITION OF THE VINEYARD VILLAGES WHERE THE WATER PUTS OUT ABOVE THE LOWER TERTIARY CLAYS, AND THE ENTRENCHED VALLEY OF THE MARNE.

you come upon exposures of successively older rocks. The older Tertiary rocks to the north are composed very largely of clays and sandstones. The Marne therefore cuts more deeply into the Tertiary plateau than its tributaries the Grand and Petit Morin in Brie. It cuts right through the Brie clays and *meulrières*,¹ through the *argiles vertes*, through the *calcaires grossières*, and *argiles plastiques* into the chalk.

Owing to the relative thinness here of the *Calcaire de Brie*, which form such a hard and resistant capping south of the Marne, the Marne right-bank tributaries have developed their valleys with comparative ease, dissecting the plateau of Tardenois into a number of blocks and ridges, of which the chief is the Montagne de Reims, between the Marne and the Vesle basins, rising to about 800 feet.² The covering of clay on the broken plateau is less thick than in Brie, with the result that swamps and lakes are less frequently met with. The higher part of the plateau is largely forested (Forêt de Reims, Bois de Courton, Bois du Roi), and villages are, for the most part, confined to the valleys and plateau edge, a contrast to conditions in southern Brie, where the population is scattered evenly over the high-level plains, where the red loam is suitable for the cultivation of beet and wheat.

VALOIS. West of the junction of the Ourcq, the capping of Brie limestone disappears altogether, leaving the plateau of Valois covered with a layer of Lacustrine limestone interleaved with sands, and blanketed on the higher parts with plateau loam. Owing to the lower level, Valois is much less dissected than Tardenois, and the coating of loam has resulted in a much more even distribution of population. Outliers of Fontainebleau sandstones form ridges of hills on the plateau, rising to heights of some 650 feet. These forested heights form a strong contrast to the generally cultivated surface of the plateau. The woods are of oak, beech, birch, hornbeam, etc., a contrast to the pine plantations of Champagne.

THE OISE BASIN

The Oise, with its tributary the Aisne, drains the north-eastern section of the Paris basin. Hydrographically, this is a transition area. The Aire, tributary to the Aisne, lies, as far as its upper basin is concerned, outside the Paris basin and belongs to the same drainage system as the Meuse.³ It rises half-way

¹ Brie is famous for its millstones made at la Ferté on the Marne.

² For the description of Reims, see p. 131.

³ See Châlons sheet, 1/200,000.

between the Meuse and Marne in the Kimmeridge clays near St. Aubain, and follows the eastern edge of the Portland limestone. Outliers of Portland beds form isolated limestone-capped hills here and there to the right of the stream, whose valley is trenched through the clays into the Corallian limestone beneath. In summer it disappears into this porous limestone for a distance of some twenty miles of its course. Flowing, as it does, between the two porous outcrops of the Portland and Corallian limestones, its tributary streams are few. At Pierrefitte it reappears from its subterranean course to flow over the Kimmeridge clays, and then enters the Portland plateau, across which it strikes diagonally in the direction of St. Menehould. In the Portland limestone it again loses much surface water, and its bed is almost dry in summer.

ARGONNE. Near Grandpré the Aire turns west and enters a much dissected plateau about eight miles wide and rising to 1,000 feet above sea-level, formed of a clayey sand belonging to the Gault deposits, and referred to by the French geologists as *Gaize*. A few miles below Grandpré it falls into the Aisne. In contrast to the lack of water in summer, the winter floods of the Aire are often very violent, owing to the complete impermeability of the Kimmeridge Clay. In the *Gaize* there is no lack of surface water and the Aisne and its numerous tributaries have trenched a multitude of steep V-shaped valleys in the soft rocks, cutting down to the Portland limestone beneath. This region is known as the Argonne. Within it the Aisne and the Biesme flow in a north-north-west direction, parallel with the Aire and the Meuse, but in their basins the Cretaceous sands are thick, and they have not been able to eat their way down to the underlying limestones. Innumerable swift streams seam the ridges that separate these longitudinal valleys, but rarely traverse them, so that communication across the plateau is rendered very difficult owing to the sticky nature of the clayey sands and the steep, sometimes almost perpendicular, slopes of the hills. Agriculture has not encroached to any extent on the forests of the Argonne, which thickly clothe the valley sides. The valley bottoms are narrow and marshy and full of dense undergrowth, forcing the roads, such as they are, to follow the ridge-tops. The whole area reminds one of what the Forest Ridges of Sussex must have been before the great forest trees disappeared in the interests of iron-working and ship-building. Water penetrates easily into the soil and is not easy to obtain on the ridges. The few villages of the uplands appear to have established themselves there not for defensive purposes, but rather because the valley bottoms are too dark and damp for habitation. Chains

of dammed-up ponds, as in the Ashdown Forest, once provided water-power and now offer fishing resources. Tributaries of the Biesme, it is true, facilitate communication eastward with les Islettes and so with Verdun, but there is no corresponding valley route to the west, and the line from Verdun has to tunnel through to the Aisne valley, which is trenched into the dip slope of the Argonne plateau. The strategic importance of the Argonne district is well brought out in Johnson's *Battlefields of the World War*,¹ where he shows how the Americans were unable to dislodge the Germans from their Argonne stronghold except by out-flanking movements to the north and south. In the campaign of 1792 the region also played an important part when the Allied army tried to get to Châlons and was defeated at Valmy.

In the south the white clayey sands of the Argonne disappear, giving place to Gault Clay, and accordingly the scene changes from barren, forested heights to a level plain streaming with water, dotted with lakes and ponds, marshland and water-meadows, and here and there with fertile stretches of cultivation, such as we have described already in the basin of the Marne.²

THE AISNE. The Aisne is essentially a river of the verdant Gault plain. Vouziers, on the edge of the flood-plain, to the left of the river, is the market town of a broad strip of fertility, five miles wide, which lies between the marshy river valley and the chalk scarp, here relatively steep and continuous. Short streams, taking their rise in the Gault, traverse the plain. A large village is situated at the mouth of each valley where it emerges from the plateau. The eastern tributaries of the Aisne in this section cut back through the *Gaize* into the Corallian limestone. Rethel lies just within the chalk escarpment in a position typical of all the escarpment towns, and in other respects the valley of the Aisne through the chalk differs little from those of the other rivers we have described. The chalk plateau west and north-west of Rethel exhibits all the characteristics of the area in the neighbourhood of Châlons. We find the same lack of surface water, the same land-shapes, the same dry valleys, the same sparseness of population. Sissonne occupies a position very similar to that of Suippe. The rivers Retourne and Suippe trench the chalk plateau to the south of the Aisne. The Vesle enters the Tertiary plateau independently. Outliers of Tertiary limestone form isolated hills standing out from the escarpment, and between the Aisne and Vesle a jutting promontory of the Tertiary Massif carries the Montagne de Reims. At the foot of the Tertiary escarpment the *argile plastique* leads to a great

¹ Published in the American Geographical Research Series, 1921.

² See p. 115.

output of water, which is marked by a continuous line of villages, all interested in viticulture.

It seems strange at first that Dry Champagne, that bleak, bare upland, should include several towns which were important commercial and industrial centres during the Middle Ages, and which still retain, to some degree, their industrial activity. Reims, like Epernay, Châlons-sur-Marne, and Provins was a route town, but a nodal point of greater significance than the others. The chalk downs, stretching for 150 miles from south-east to north-west, offered the most practicable route for roads coming from the Midi and from the south-east passes. The poverty of soils on the chalk, the difficulty of obtaining water, precluded the development of an agglomeration of population except on the rivers. There were no resources of running water nor ferruginous sands nor forests to encourage the development of the iron industry in a multitude of forges, as in *Champagne humide*. On the other hand, it was possible to drive the roads straight without circumvention of marshes and the porous rock formed a good foundation; and good communications are as essential a factor in developing industry and commerce as the presence of raw materials.

REIMS. Reims lies at the intersection of the great Gallo-Roman road from Lyons and Provence to Belgium and the road along the Vesle valley to Soissons (Noviodunum). Its nodal position made it a commercial centre. Like Epernay, Châlons, and Provins, it had a great annual fair. It was naturally a fortified city, and its boulevards mark the successive stages of extension of the walls. The town very early developed a woollen industry, using local wool, like Châlons. The wine industry did not develop till much later, though the vineyards of the Tertiary escarpment, *La Montagne*, were renowned for centuries before. Sheltered from moist winds and cloud, the well-drained, limy slopes at the foot of the *Falaises de l'Île de France* provide excellent vineyards, despite the high latitude. The wine is prepared in ancient cellars excavated in the chalk, which here forms the base of the escarpment. These played an important part in the lives of the civilians and soldiery during the terrific bombardments of the 1914-18 War. They were extensive enough to shelter not only such civilians as remained in the city but troops sent back to rest behind the line, and they were connected by subterranean passages with the front-line trenches. Reims is the chief market for champagne wine.¹ Wool-combing, carding, and spinning are still carried on in the town, which has developed large industrial suburbs as a result of railway facilities.

¹ See p. 126.

The manufacture of flannel and light cloths are specialized industries ; the villages of the Vale and Suippe valleys had many looms that worked for Reims. The nodal position of Reims and the importance of its fortifications in the defence of Paris brought upon it sore tribulation in the War. Half of the buildings were demolished, including all the wool factories, those of the town, and those of the neighbouring valleys, and the magnificent cathedral, witness of the high ecclesiastical position held by the town in the past, was sadly damaged. Reconstruction has meant the elimination of the smaller works and the grouping of the industries under a few powerful concerns. The population in 1906 was 102,800, in 1921 it had dropped to 76,600, but had risen again in 1936 to 109,344.

THE OISE. The Oise is the connecting link between the Brussels basin and the Paris basin. Its chief head-waters rise in the impermeable rocks of the Ardennes Massif, except for the Thon, which rises in the Jurassic rocks farther south. Other head-streams take their rise in the Gault Clay, and then cut deep valleys in the chalk, exposing the clay beneath. Vervins is the market centre of this clay region, where fertile valleys with rich pastures exchange their produce for that of the chalk uplands. The Oise and Serre, after crossing the chalk, unite just within the Tertiary *falaise*. Here stands the town of La Fère, which formed, with Laon and Reims, the defence of Paris against attack from the north-east.

Oise and Aisne now traverse the Tertiary plateau in broad valleys with slopes relatively gentle below, which, however, become steep at the top owing to the presence of limestone, which caps the hills. The two rivers draw together in the neighbourhood of Compiègne, where a great forest has been preserved on the infertile clay (*argiles plastiques*). Between Seine and Marne to the south and Oise to the north lies the great limestone plateau of Senlis. Here once more lack of water is the characteristic feature. Roads run for miles in straight lines across the plateau, converging on Nanteuil and Senlis, where no fewer than seven roads come together. Patches of Fontainebleau sandstone, forming outliers upon the limestone, stand up as wooded ridges. Senlis lies in a gap between the forests of Halatte and Chantigny. It holds a strong position on a steep-sided spur of limestone between two streams and was an important Roman station on the road between Paris and Belgium. North of the Oise the Tertiary limestones are replaced by a plateau of Cretaceous chalk called the *Vexin Normand*. This is covered, except in the valleys, by considerable thicknesses of Tertiary Clays and *limon des plateaux*. It forms the divide between the Seine and Somme

drainage. The general elevation is not much above 300 feet, and much of the surface is plough-land. South of Clermont, however, outliers of the Tertiary plateau take the form of steep-edged blocks of upland, rising abruptly from a trench worn in the *argiles plastiques*. The summits of these *buttes* are forested, particularly towards Clermont, and all their slopes are thickly wooded. The railway from Beauvais to Compiègne follows the vale at the foot of the Tertiary escarpment here. The lower Thérain drains a part of the chalk plateau, covered with clay-with-flints, which produces so impermeable a subsoil that the general aspect of the country is almost *bocage*-like, because of the number of copses and small woods and the orchards that surround the walled farms. Wheat and forage crops do well on the heavy soils. Beauvais, at the confluence of the Thérain and Avelon, the market of these waterless chalk plains, is the chief town of the Oise department. It has long outgrown its ancient ramparts, which still surround the old town, with the cathedral and fortress-like bishop's palace, but it has retained its ancient industry of tapestry- and carpet-making.

Below Compiègne the Oise valley becomes more and more industrial. Compiègne itself has increased in population by 6,000 in the last half century, but this is only in part due to industry. The great forest which made the town a royal residence attracts many tourists, and large residential suburbs have grown up on its edges. Venette, using local sands, has glass-works, for which salt is brought from Varangéville in Lorraine. Rock-salt comes to Verberie, six miles downstream. Wherever the railway is in contact with the canalized Oise manufactures have sprung up. There are large constructional iron- and steel-works at Montataire, at the confluence of the Thérain and near to the important railway junction and river port of Creil. Quarries for lime- and building-stone and sands from the riverside provide valuable cargoes for transport on the canalized Oise; while coke from Paris and coal from the northern coal-field feed the factories and provide for domestic requirements. Creil has important chemical works.

Below Creil the Oise may be said to enter greater Paris, for the urbanization of the villages along the lines of communication is going on apace, and the lower land and the areas undesirable for settlement are being rapidly filled up with factories of all sorts, working for the requirements of the metropolis, as well as for wider markets.

BRAY. The Thérain, by its tributary the Avelon, drains an area of great geographical interest. One of the anticlinal folds that furrow the northern edge of the Paris basin extends south-

wards here to cross the Oise. The arch has been faulted along the eastern dip slope, as in the sill of Artois, and the chalk has been eroded over a long spindle-shaped area, stretching from Noailles in the south to some miles north of Neufchâtel, thus forming a small region of the Wealden type, which is known as Bray. The anticlinal fold stretches north to the coast at Dieppe, and is discernible for several miles south of the Oise, chiefly by the faulted scarp that accompanies its north-eastern side. The area resembles, as Demangeon puts it,¹ a buttonhole, the edges of which are represented by the lip of the chalk, whose scarped edges face inwards. In the south they overlook a rolling country of sands and clays belonging to the Lower Cretaceous and drained by the Avelon, while in the north they face an oblong mass of Portland limestone and marl, holding the position of the forest ridges in our own Weald. This is drained by the Epte, which flows along its south-western edge, and whose right-bank tributaries collect the waters of a vale in the Gault Clay called the Vallée de Bray. The Andelle, which joins the Seine south-east of Rouen, has cut back through the chalk escarpment into the clays and sands of this weald of Bray near Forges-les-Eaux. North-west of this point the drainage is to the Channel at Dieppe, by the river Béthune. Structurally this region of Bray belongs to the coastal regions of Picardy and Artois, to be described later, but the exposure of soft rocks has led to invasion by the Oise tributaries and the inclusion of its southern portion in Beauvais. The sandy marls and sticky clays that predominate in the weald of Bray form soils that are best utilized for pasturage. Dairy-farming is practised, and the region is famous for its butter, and particularly for its cheese. Gournay, on the Epte, used to be noted for its dairy produce. Neufchâtel, on the Béthune, in a country that is not very dissimilar from the Argonne, is noted also for its cheeses. Cream cheese from this district, known as *Suisses*, finds a good market in London as well as in Paris.

PARIS

Paris lies just below the junction of the Seine and the Marne. The slight parallel undulations of the earth's crust to which we have already drawn attention ² has caused erosion along definite east-west lines, so that the northern part of the Tertiary Massif is divided into long strips of upland lying east and west separated by broad parallel vales—the Grand Morin, the Petit Morin, the Marne, the Aignon, the Ource, the Aisne, the Lotte, the Oise. The contrast is thus great between the broad, level upland plains

¹ A. Demangeon : *La Picardie*, 1905, p. 31.

² Dollfus, *A. de G.*, 1900, pp. 413-33.

of Gâtinais and Beauce, and south-west Brie and the deeply dissected ridges of northern Brie, Valois, Soissonais, and Laonnais.

This ridge-like effect of folding and erosion played an important part in the defence of Paris in the Great War, facilitating attack from the east but making it very difficult from the north.¹

As a result of the slight undulations in the earth's crust just mentioned and of erosion in diluvial times, the centre of the Paris basin is occupied by two broad, parallel trenches, filled with diluvial detritus and separated from one another by a long ridge of Paris Gypsum capped with Brie limestone. The city of Paris occupies the southernmost of these trenches which is followed by the Seine.

It is probable that the north-west-south-east trend of the trench in which Paris partly lies, as well as the general direction of the Seine at and below Paris, is due to an anticlinal fold, upon which the resistant *Calcaire de Beauce*, being very thin, was quickly worn away, giving access by eroding agents to the softer Fontainebleau sands, which were easily washed out. The hydrography of Paris conforms to the general drainage characteristics of the basin as a whole, the streams flowing either convergently upon Paris, an ancient consequent system resulting from the basin-like dip of the rocks, and disregarding recent tiltings and foldings, or south-east-north-west following the line of Alpine folds of north France. The city spreads north of the river on to the ridge of Paris Gypsum, into which the Seine has cut in a wide bow. South of the Seine it occupies a plain of old alluvium in the bend of the river and the northern spurs of an isolated portion of the plateau of Brie, between the Seine and its small tributary, the Bièvre, where the *Calcaire grossière de Paris* emerges from beneath the Brie limestone. The western spur forms Montrouge and Montparnasse and bears the Panthéon. The eastern spur carries the Place d'Italie. To the north and west Auteuil, Passy, the Place de l'Etoile lie on the higher gypsum. Montmartre is an isolated mass of Brie limestone, 420 feet above sea-level, and Ménilmontant, with the cemetery of Père Lachaise, and a distributing reservoir that receives water from the Thuis, occupies the western extremity of a long ridge of the same formation which is cut off from the main plateau of Brie by the valley of the Marne. The suburbs of Paris occupy for the most part the valley bottoms and slopes of the streams that dissect the calcareous plateau, while the plateau tops are still for the most part either wooded or cultivated or occupied by public or private parks: Bois de Meudon, Bois de Fausses Reposes, Parc de St. Cloud. Certain of the more salient promontories of the plateau form commanding

¹ Douglas W. Johnson: *Battlefields of the World War*, p. 238.

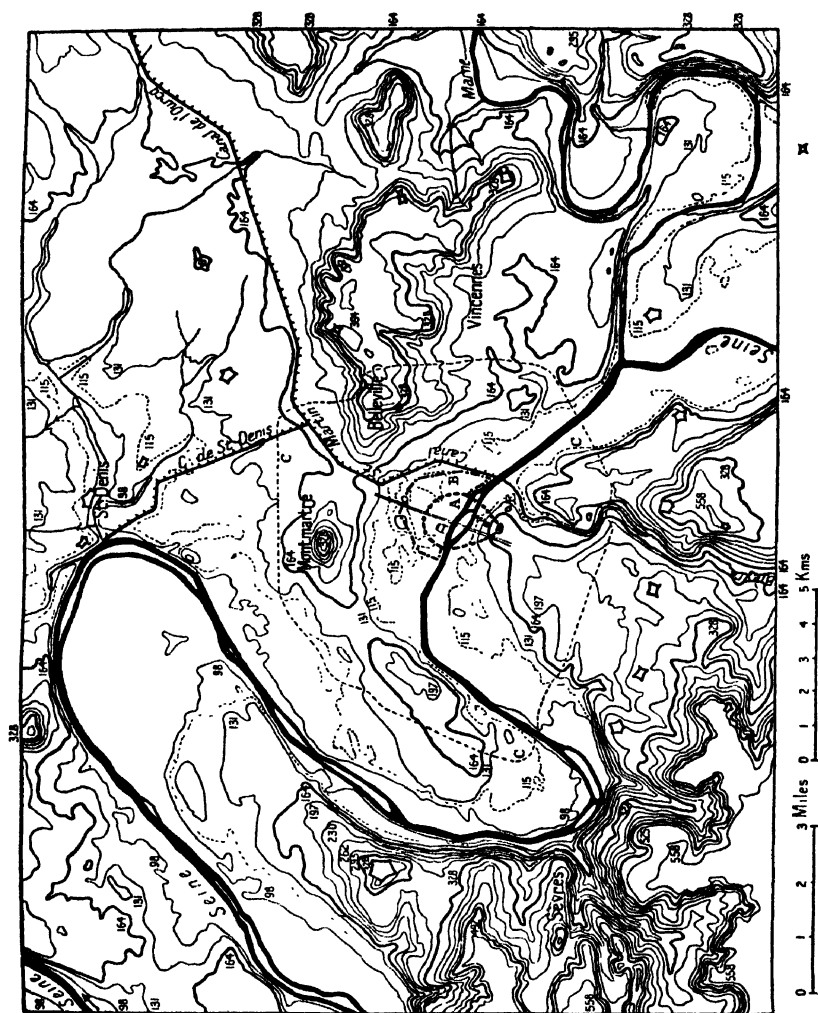


FIG. 28. PARIS. THE SEINE AND ITS TRIBUTARIES HAVE ETCHED A DOUBLE TRENCH INTO THE TRIARTY LIMESTONE PLATEAU. THE CITY OCCUPIES THE SOUTHERN TRENCH AND THE SLOPES OF THE LIMESTONE SPURS. INDUSTRIAL SUBURBS (SEE FIG. 29) OCCUPY THE NORTHERN TRENCH IN THE LOOP OF THE SEINE. POPULATION AVOIDS THE PLATEAU TOPS.

- A Encinte of Philippe Auguste
- B Encinte of Charles V
- C Fortifications of 1841-45
- D Roman Road
- E Roman Amphitheatre
- F Roman Baths
- Forts

positions for the forts of Paris : Fort de Bicêtre, Fort de Châtillon, Fort du Mont Valérien, Fort de Nogent.

We see then that the position of Paris, whether viewed in its local or in its wider environment, is a very interesting one. To the south and south-east of it lie the great grain and pasture plateau lands of Beauce and Brie. To the north, the fertile plateau of the Ile de France drains southward to the Marne and Seine, and, beyond, the loam-covered plateaux, dissected by the Oise, carry the grain-lands through Picardy to the rim of the Paris basin and the sea. The Marne, the Seine, and the Oise, with their tributaries, converge on Paris, opening a succession of passage-ways through one limestone plateau after another, linking *pays* with *pays* and making possible a concentration of interests and a centrality of administration almost unparalleled.

Inviting access to the centre, as these valley-ways do, they nevertheless are provided with natural safeguards should the advance on Paris be a hostile one. The outward-facing scarps of the limestone outcrops offer so many bulwarks of defence, causing the line of attack to concentrate on the river-gaps, where again, in the outliers of resistant rock that jut out on either side of the entrance to the gorges, Nature has provided fortresses and posts of observation which stand ready to the hand of the defender.

Locally, the low, river-eroded spurs of the limestone basin of which Paris is the centre form sites for the defence of the city, while the island of Notre Dame—the site of the original settlement—was also one chosen primarily for its defensive position.

Intensely interesting is the contrast between the converging valley-ways and the centralizing influence resulting therefrom on the one hand, and the imperial plateau-ways—through ways, remote from local life, and serving extraneous interests. These routes avoided the valleys, the woods, and the marshes, heading as directly as might be for the next stronghold along the route. Early Paris, essentially a river town, had less significance for the makers of through roads than Chartres and Reims, situated the one on the route to Rouen, and the other on the road to Belgium.

The earliest historical Paris was the headquarters of the tribe of the Parisii, situated on a small island in the Seine, a spot easily defensible, and yet, by reason of the island, in a position where the river was relatively easily bridged. The Romans found it a small market town and trading centre near the convergence of important streams, amongst which we must count

the little Bièvre, whose valley led southward towards the Loire and Orleans. The settlement lay off the main routes of Gaul, but derived a minor importance from its situation on the road to Brittany. The north bank was low and occupied by a marsh—Le Marais—which represents an older channel of the river, so that approach was difficult from this side. As in the instance of London, it was the bridge that decided the Roman occupation, the bridge that carried the road from Orleans and the south to the controlling point of Senlis in Valois.¹ But the steep bank on the south side, and the fertile uplands of Hurepoix beyond, must have been factors exercising some influence.

The little island site did not long suffice for the Romanized settlement. The bluff on the south side, which they knew as the Mons Leucotitius, proved more attractive. It commanded the bridges and was preferable for residence. Moreover, here was to be found excellent building-stone. On the eastern slopes of the Mons Leucotitius was built an amphitheatre capable, it has been estimated,² of holding about 16,000 persons, and great public baths on the northern slopes where stands to-day the Collège de France. Here too grew up the residences of officials and of wealthy burghers.

Lutetia—for this was the Romanized name of the city which was founded by the Parisii—grew and prospered under Roman rule. Roman roads led from it north and south along the line of the Rue St. Martin–Rue St. Jacques, and the waterways were used. There is evidence that a wealthy corporation³ of watermen navigated the Seine as early as the first century. Water was brought from the plateau of Wissous along the valley of the Bièvre to supply the city. The aqueduct entered the city along the Rue St. Jacques. This channel was ten miles long, but does not appear to have been capable of supplying more than 5,000 persons. If this were the sole supply of water the settlement could not have been large. But, for the island and the bank sides, the use of Seine water also must have been possible.

With the beginning of the barbarian attacks in the third century and the resultant demolition of the suburb on the south side of the river (left bank), Paris had to withdraw within the island, from which she did not emerge for another 700 years. This withdrawal, however, meant greater strength. About the year 300 the Romans built a wall to protect the island, which was thus enabled to maintain its freedom though it remained a small and unimportant place. In 497 Paris opened its gates to the Frankish

¹ Cormille Jullian : *Le Paris des Romains*, Paris, 1924.

² See Fig. 28.

³ Albert Demangeon : 'The Port of Paris', *Geographical Review*, November 1920, pp. 277–96.

king, Clovis, who, later, made the town his capital, thus linking his possessions north and south of the Seine, and expanded the city once more by building his palace on the slopes of the Mons Leucotitius, on the site of the Roman baths. Higher up the hill he built the church of St. Peter and St. Paul, which later became the burial-place of Ste. Geneviève and took her name. Paris now developed as an ecclesiastical city and as a centre of learning, but trade, commerce, and industry also grew around the great fortified ecclesiastical houses. Under the Carolingians, however, Paris decreased in political importance, and under Charlemagne ceased to be the Frankish capital, as the centre of gravity shifted to the Rhine. Nevertheless the city had gradually expanded. On the plateau behind Ste. Geneviève the forest clearings gradually increased, as agriculture was extended, to make possible the feeding of the growing city community. The river traffic downstream, which had practically ceased with the downfall of the Romans, revived. The city spread to the right or north bank, settlements grouping themselves round St. Martin des Champs, where a fair was held annually. Then, in 845, the Northmen sailed up the Seine and, after renewed attacks, once more the hill on the left bank, now known as La Montagne de Ste. Geneviève, was pillaged and burnt, the colony round St. Martin des Champs was laid waste, and the citizens once more retired to their island, which they strenuously and successfully defended under Eudes, Count of Paris, who was elected king in 888. In more peaceful times the church on the hill was restored; an abbey was built beside it which afterwards became a famous seat of learning, the forerunner of the university and the Quartier Latin. It was towards the end of the tenth century that, under Hugh Capet, the natural nodality of Paris began to tell.¹ The great imperial routeways had avoided Paris, making straight across the chalk and limestone plateaux from the Rhône corridor to Reims and Chartres and the Channel ports. Now the natural valley-ways began to come into their own. The Seine traffic, which disappeared for 700 years after the withdrawal of the Romans, had been gradually resumed. The Hanse merchants had become the dominating power in municipal affairs by the twelfth century. Their hall on the Place de la Grève became the municipal centre of the town.

Here developed also the market and the exchange and business quarter generally, and here the houses soon crowded as the value of land increased. At St. Denis a great annual fair was established, at which merchants gathered from all parts. Philippe Auguste built the original Halles—a great walled and roofed

¹ Dubech and d'Espezel: *L'Histoire de Paris*, Paris, 1926, Chap. II.

market which became so famous that merchants from the outskirts of the Paris basin sought stalls to offer their wares there. Between Les Halles and St. Martin were a number of narrow streets in which the purveyors of the city plied their trades—*la Draperie, la Cordonnerie, la Boucherie*, etc.

The arrangement of early medieval Paris differed then from that of London. The Westminster of Paris occupied the rising ground of the Mont Ste. Geneviève on the south or left bank. The port and the market occupied the low-lying right bank on the north. The island of the city was too restricted for the development of commerce and industry. It remained the chief ecclesiastical centre and at times the royal residence.

Philippe Auguste, by encouraging the commercial side of the city life, by building for his residence the Louvre on the right bank, from which he centralized the administration of his realm, and by organizing the educational establishments on the left bank into a university to which he gave his patronage, opened a new epoch in the development of the city.

In the fourteenth century the low-lying north bank, *Le Marais*, which formed an aristocratic quarter, was included within the walls. By the end of the eighteenth century the city had spread to include the sites of the Place de l'Etoile in the west, the Gare de l'Est in the north, the Place de la Nation in the south-east, and the Place de l'Italie in the south. The outer boulevards mark the *enceinte* at this period. By the middle of the nineteenth century, with a population of over a million people, the city had extended to the line included within the modern fortifications. These were demolished in 1922,¹ for they were considered to be obsolete in modern warfare, and in the twentieth century the houses had spread far beyond them, over a radius extending from two to six miles, and covered the whole department of the Seine. The population in 1936 was registered as 2·8 millions in Paris itself, and 4·96 millions for the department of the Seine (including Paris), which might be considered as corresponding to the London County Council area of London.

The localization of the various arts and crafts, so marked in the Middle Ages, is not very definite to-day, but the *Quartier Latin* is still the scholastic quarter, the *Halles* still remains the great food market of Paris. The *Marais* has ceased to be an aristocratic residential area and has become the Whitechapel of Paris, harbouring some 30,000 Russian and Polish Jews. In the neighbourhood of Montrouge, south of Montparnasse, we find the

¹ The removal of the fortifications has greatly facilitated the entry of traffic into Paris, and the joining of the city to the adjacent suburbs, Neuilly, to-day, is continuous with Paris.

artists' quarter. The Fleet Street of Paris is a quarter that stretches northwards from the Opéra and the Bourse; the Rue de la Paix, the Rue Royale and the Rue de Rivoli form the 'West End' shopping area, the centre from which emanate the dictates of *la Mode*. Ménilmontant on the eastern hill-slopes and Montrouge in the south are artisans' suburbs. The residential area of the more wealthy classes of Paris lies chiefly to the north-west.

Outside Paris proper and the zone of the fortifications (now being converted into open spaces and recreation grounds) the department of Seine forms a ring of residential and industrial suburbs, broken here and there by the higher parts of the limestone bluffs of the surrounding plateaux. Above Paris lie Ivry-sur-Seine, Alfortville with Maisons-Alfort and Charenton with Conflans at the confluence of Seine and Marne. They are served by the latter waterways and by the S.N.C.F. Railway, and are busy industrial areas. Ivry, with Vitry and Choisy-le-Roi, make beer, chocolate, and farinaceous foods; have rubber, chemical and leather works; make refractory pottery, porcelain, glass, and tiles and steel castings, and have foundries for copper and iron. In the area between Seine and Marne, Alfortville and Maisons-Alfort add soap and paper manufacture to the chemical group of industries, and liqueurs and fruit and vegetable preserves to the alimentary group. Hosiery-making is also carried on. Charenton with Conflans, besides chemical, paper and canning works, make liqueurs.

Below Paris, Issy-les-Moulineaux, on the left bank, and Billancourt on the right, follow the same occupations—chemical, soap, and leather works, while the alimentary group of industries is represented by biscuit-making. Here are also copper and bronze foundries and a factory for aluminium ware, and important aeroplane works. On the slopes of the Bois de Meudon and St. Cloud the population is chiefly residential, though we must not forget the famous china factory of Sèvres; but from Suresnes to the docks at St. Ouen industries occur all along the river, and in the network of railway lines that intersect the low area within the north-west loop of the Seine. Neuilly, Levalloir-Perret, Clichy, St. Ouen, and St. Denis on the right bank, Puteaux, Courbevoie, Asnières, and Gennevilliers on the left, have all industrial importance. The suburb of Nanterre on the west side of the bend, where there are metallurgical works, also comes within the economic region of the Seine department. Works requiring much space, much coal, and heavier raw material have developed downstream. Steel castings are made at Courbevoie, St. Ouen, and St. Denis, and steel for special requirements,

copper, and bronze are worked at St. Ouen. At St. Denis there are boiler-works. Motor engines are made at St. Denis and La Courneuve, to the south-east of this town. Asnières, Levalloir-Perret, and St. Ouen make machine tools. At Puteaux, Nanterre, and Boulogne-sur-Seine aeroplanes are made.

Motor-car works are situated all along the Seine to the north-west of Paris, on both sides of the river loop. A dozen and more of well-known firms have works at Suresnes, Puteaux, Courbevoie, Bois-Colombes, Levalloir-Perret, Gennevilliers, and Argenteuil. Most of these places have developed in connexion with gas-works and imported phosphates and other raw material, chemical-works of various kinds, soap-works, sugar-refineries, and paper mills. Gennevilliers, besides providing large quantities of sand and ballast for constructional purposes, has very important gas and electricity works. It has developed important wharves on the river, for the import of coal, oil, etc.

St. Denis, standing on a mound at the confluence of the marshy course of the Rouillon with the Seine, Argenteuil, Gennevilliers, etc., owe their recent industrial expansion to the convergence of railways on the most northerly bend of the Seine, where it crosses the low trench in the plateau referred to on p. 135, and to the cheap, unoccupied land of this marshy district, and the facilities it offers to the development of rail and canal transport. This area may be compared with the areas of the Lea and Dagenham marshes below London. In these flats, for the same reasons, we find the great aerodrome of Le Bourget, served by the great north-east road from Paris and by the Chemin de Fer du Nord.

Many works have sprung up also in the railway network of the Plaine St. Denis to the north of Montmartre.¹

Space forbids any further development of the interesting theme of geographical distributions within and about the French metropolis, but we have said enough to show that Paris, besides carrying on all the usual functions of the seat of government, administration, and finance, is one of the greatest, if not *the* greatest, manufacturing centre of France, as well as the principal market. Commerce, including both home and foreign trade, as well as the administration and control of industry, is concentrated in Paris.

UPPER NORMANDY

CAUX. Rouen, half-way between Paris and the sea, is the centre of a limestone plain 600 feet above sea-level, composed of chalk covered with a relatively thin layer of clays and loams. It

¹ 'Dormitory' Paris extends for many miles beyond the Seine department along the main railway lines, which are gradually linking up towns and villages to form residential suburbs; and between the main lines motor transport is playing an important part in covering the open spaces with houses.

is bounded on the north by the Channel, on the east by the weald of Bray, on the west by the clay lowlands of *Bessin* and the *bocage Normand*, on the south by the hills of Alençon and Perche, which represent an upswelling of the Armorican Massif.

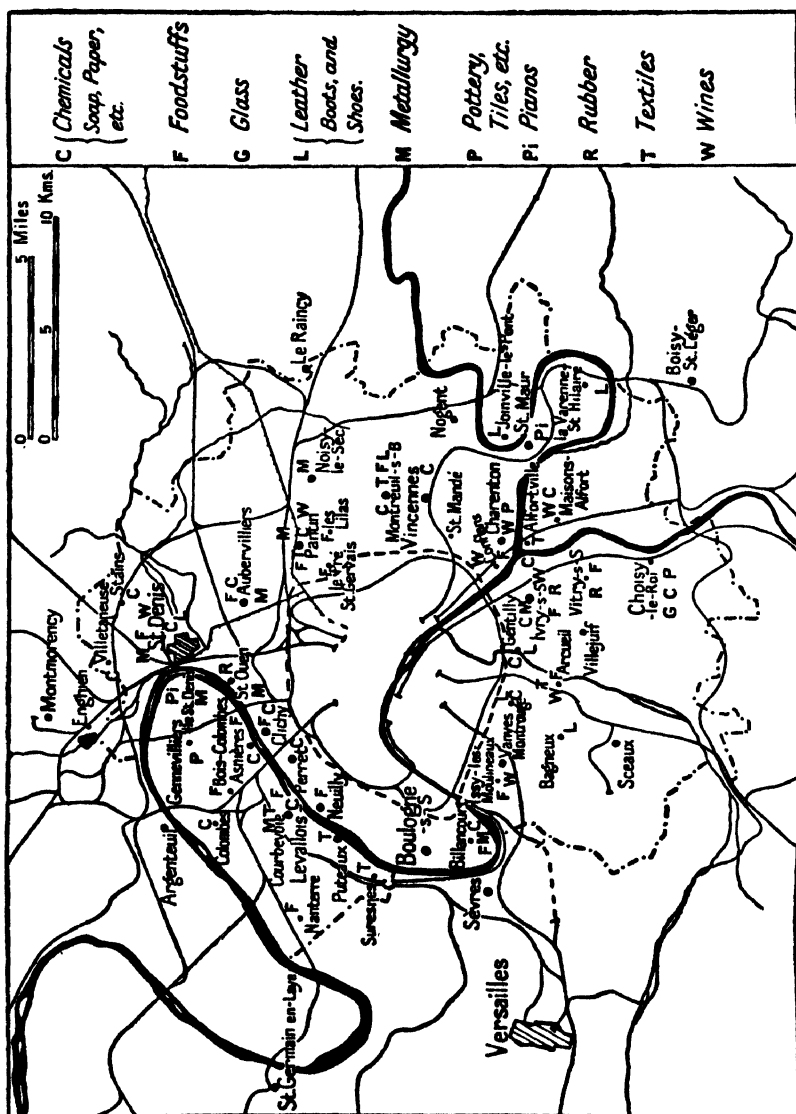


FIG. 29. INDUSTRIAL PARIS

The Seine has trenched its valley into the plateau. Its great incised meanders, whose loops were determined by the crumpling of the chalk in Tertiary times, have been scoured and emphasized

by the tidal currents. Everywhere the land is under the plough, save on the great bluffs of chalk that are isolated by the loops of the Seine, where, owing to the steepness of the drop to the valley, the land is left to forest. Here we have a repetition of the wide, monotonous stretches of hedgeless ploughland, mile after mile, with nothing to arrest the eye but the lines of plantains bordering the roads or an occasional orchard or small plantation. The high-roads avoid the villages, so that the traveller, unless he take to the by-roads, sees nothing of the life of the plateaux. In the autumn sheep are seen feeding over the stubble and cattle tethered along the edge of strips of clover or lucerne, women raising turnips or beet, or the ploughman at work with half a dozen stout horses. In the winter the wind blows keen over the plateau and even in summer there is always a cool breeze. The farms are protected by rows of elms growing in baulks of earth. But before the harvest, when the land is golden with grain, these wide plateaux, cultivated to the horizon, have an impressive beauty of their own and convey a sense of the fundamental strength and resource of the land. Between the main roads the local roads form a close-meshed network, linking the villages and hamlets and groups of farms, which are never more than a mile or a mile and a half distant from one another. The farms are built round yards whose walls are generally of flintstone and *torchis* (clay bound together with straw), which, when it is out of repair, has a very dilapidated appearance. The houses are often of brick; some of them are timbered and thatched.

Such is the *pays* of Caux. Cut off from the sea in the north by high cliffs, which are only notched by the short streams whose creeks give some slight shelter to the little fishing and trading ports, the people of the plateau have not much intercourse with the life of St. Valéry-en-Caux, Fécamp, and Etretat, and the number of minor *plages* strung out along the coast. Between Etretat and Le Havre the reddish chalk rises sheer to 300 feet and more, in an unbroken wall. The truncated ends of dry valleys serve but to give an undulating line to the top of the cliffs, or at best mitigate but slightly the steep descent to the shore. In the south of the plateau the water puts out along a line that runs roughly through Clères, Pavilly, and Bolbec, and the issuing streams, in their short course to the Seine, have been forced to carve deep valleys, cutting through the *limon* that clothes the higher slopes, exposing the clay-with-flints on their slopes, and cutting into the underlying chalk. The cold, impermeable soils on the steep slopes give little chance to the agriculturist, whose régime ends with the plateau edge, and the southern slopes of

the plateau are perforce left to woodland and pasture. But the streams, flowing swift and clear to the northward-swinging curves of the Seine, encouraged the establishment of industries along their banks, turning numberless water-wheels in their course. The small towns of Clères, Pavilly, Bolbec, St. Romain, and Montivilliers lie at the heads of the industrial valleys, and form connecting links between the main valley and the plateau; Duclair, Caudebec, and Lillebonne were the outlets to the commerce of the Seine in very early times, and mark the early settlements of the northern invader. Thanks to their swift streams, they developed textile and paper mills. The valley life developed from below.

ROUEN. But Rouen on account of its favourable position at the lowest bridge, on a tidal river, in the heart of a fertile and varied country, became the entrepôt for the overseas trade of northern France. It developed ship-building and fitted ships for the trans-Atlantic trade. To-day the bridge town, at the junction of sea and river navigation,¹ at the head of the tideway, at the junction of the industrial valley of the Cailly, still dominates the life of the lower Seine. The total population in 1936 was 117,854. Its diverging railways have made a manufacturing annexe of the Cailly valley, and by tunnelling through the plateau have drawn into its radius the St. Austreberte valley, where industrial Barentin has far outgrown its neighbour the old market textile town of Pavilly. Darnetal and Mesnil-Esnard are suburbs that have developed in two little valleys that converge from the east. A completely modern town, equal in size to the Rouen of the north bank, has developed round the church of St. Sever on the lower slopes of alluvial terraces that flank the almost isolated plateau block of the Forest of Rouvray. Here there was plenty of room for industrial development, for the river hugs the outside or northern edge of its flood-plain in the loop, and the valley floor is crowded with mills and railway sidings, warehouses, and wharves. The quays on both banks have encroached on the river.

The textile industry of Normandy began in the usual way—in the necessity for the peasants to be self-sufficing in the days when communications were non-existent or very difficult. Sheep's wool procured locally was woven into cloth on the farms. Later the linen industry developed. With the invention of the spinning machine the farm industries migrated to the valleys and the industry developed there with the introduction of steam-power. The relation of farm and factory persisted, however, from the point of view of labour supply. The introduction of cotton

¹ There are a barrage and locks at Elbœuf, twelve miles upstream. The limit of salt water is at Pont Boieldieu in the centre of the town.

encouraged those industries which were nearer the Seine valley and which could get their raw material from the Seine with the smallest amount of transport.

Along the whole fifteen miles of the loop of the Seine on which Rouen stands, from Grand Couronné to Oissel, there is a continuous line of factories following the railway in the flood-plain of the left bank of the river. Again, from the weaving

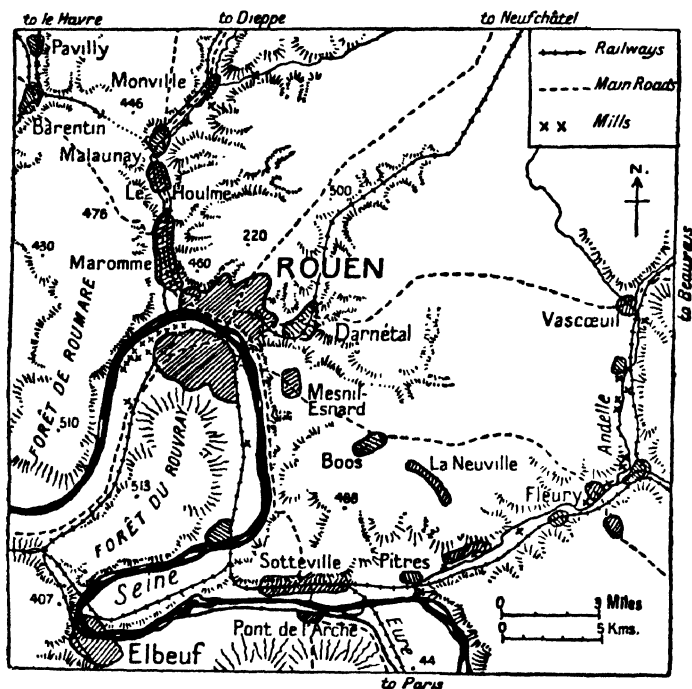


FIG. 30. THE PORT AND INDUSTRIAL AREA OF ROUEN. THE SEINE HAS ETCHED SO DEEPLY INTO THE CHALK PLATEAU THAT INDUSTRIAL DEVELOPMENT IS CONFINED TO THE VALLEYS. THE IMMATURE DRAINAGE SYSTEM IS REFLECTED IN SWIFT STREAMS WHICH WERE OF GREAT IMPORTANCE IN THE DEVELOPMENT OF THE TEXTILE INDUSTRY. THE LOWER PLATEAU IS CULTIVATED; THE HIGHER SPURS ARE WOODED.

mills of Elbœuf on the south bank, at the head of the next upstream loop, a line of industrial activity stretches eastward, via Pont de l'Arche, where the Paris road crosses the Seine, and up the valley of the Andelle towards Bray. These suburban districts have grown rapidly at the expense of the less accessible communes on the plateau, though their population has been notably increased by English and Belgian settlers (the latter

chiefly as textile workers and the former as mechanics) since 1918.¹ Though textiles bulk largest in the manufacturing activities of the Rouen district, dye-works, as at Oissel, and pulp, cellulose, and paper-works as at Grand Querilly, Croisset, and Barentin, are found. The cotton industry is mainly concerned with spinning, but weaving is carried on also along the Seine valley, and in Rouen there are important weaving establishments, bleaching and dyeing works and clothing factories. To-day, chimneys belching black smoke emerge from the side valleys and are scattered and grouped all along the main valley south of Rouen, and at intervals along the drained flood-plain, all the way to Le Havre.

Rouen and the lower Seine form the gateway by which the Paris Basin communicates with the Channel. It is the seaport of Paris, which it supplies with petroleum products and other bulk commodities by water. This traffic we shall deal with in Chapter XIV, on Communications. It is also a general seaport. Towards the end of the last century its function as a seaport had dwindled almost to nothing owing to the growth in size of the seagoing vessels. The development of an outport at Le Havre gave a further blow to its traffic. In 1848 diking of the Seine was begun. This and other regulations so improved the channel that there is a mean depth of twenty-five feet, although the depth may fall to less than three feet at low water spring tides. The port revived rapidly, till in 1914 it seemed to have reached the limit of its expansion, when the Great War spurred the town to fresh efforts. More than a quarter of French imports by weight come to Rouen for distribution. This is because Rouen is essentially a coal importing port. In the years 1926-29 it imported over 3,000,000 tons of British coal and anthracite.² Mineral oils, wine, and alcohol come next in importance by weight. Wood-pulp, Baltic timber, ores and pyrites and phosphates each reach a tonnage of over 200,000. Exports from Rouen are only about a tithe of the imports, and consist of such heavy articles as sand,³ plaster, cement, mineral oils and steel.

THE LOWER SEINE. Below Rouen the valley of the Seine widens rapidly towards the mouth near Quillebœuf. The alluvial flats have been drained and the river channel is confined within dikes. From Tankarville, where a promontory of the plateau juts out to the river, a canal takes off and follows the foot of the plateau to Le Havre. This enables lighters bound to and from Rouen to avoid the estuary of the Seine, and was a great boon

¹ J. Levainville : *Rouen pendant la Guerre*.

² In 1930 Rouen imported over 5,000,000 tons, but quota restrictions caused a steady fall to about 3,000,000 tons in 1938.

³ From Fontainebleau to England for glass-making.

to Rouen before the channel was sufficiently deepened to enable sea-going craft once more to reach the port.

LE HAVRE. Le Havre lies sheltered beneath the western extension of the plateau of Caux at the entrance to the estuary of the Seine. Its dock basins are excavated in the broad belt of silt that follows the north shore of the estuary. The port is alien to the plateau behind it. It is of typical modern growth, born of the necessity to provide deep-water accommodation for modern liners. It is a national as well as a local port. It supplies Rouen and the whole of France with cotton, being the third cotton port of Europe, its imports being mainly from U.S.A. It also imports wool in large quantities. To its nearer hinterland of Paris and Rouen it supplies coal, mineral oil, and timber. It shares with Bordeaux and St. Nazaire traffic with the Americas, having lines to New York and to the Panama Canal. It has also a heavy coastal trade, and traffics generally with the Baltic, Channel, and North Sea ports. Le Havre is a port of call for liners using the Channel, and is especially utilized by American visitors to the Continent, being a serious rival of Cherbourg in this respect. There is a regular passenger service between Le Havre and Southampton. In addition, Le Havre has developed as an entrepôt port, particularly for Brazilian coffee, which is distributed thence all over Europe, and deals also with tropical produce, cocoa, sugar, spices, etc., performing the same services as London and Hamburg. The annual freight handled, including coastwise movements, is in the neighbourhood of 5,000,000 tons. Lighter traffic to Rouen has decreased since the improvement of the channel, to which the colliers can now obtain direct access.

South of the Seine the chalk plateau of *Haute Normandie* continues southward in the *Campagne de Neubourg* through Ouche and Thimerais to the river Eure. It differs from the *Pays de Caux* in that the chalk plateau has a thin covering of Tertiary rocks—sands and clays—the higher parts of which in their turn are hidden by *limon*, except in the valleys. The upper valleys of the Rille and Eure are well developed, and there are many head-streams, with the result that the land is much more broken and the scenery more varied than in Caux. Towards the Seine, however, where the Tertiary Clays are lacking, there is but little difference in the cultivated plateau from the conditions north of the river. The Eure valley offers a contrast to conditions on the upland. The wide valley bottom is cultivated, and the road winds from village to village above the flood-plain. The valley slopes are wooded and steep. Nothing could be more striking than the contrast between a journey through the close, sheltered

valley, with its winding road, joining village with village, its water-meadows, and intensive cultivation on the reclaimed marsh, and the straight course across the plateau, with the incessant breeze, wide horizons, and, above all, the sense of solitude. The contrast is emphasized by the suddenness with which the valleys come into view and the abruptness of the descent. Louviers, Evreux, and Dreux are the market towns that link plateau and valley. The beauty of their ecclesiastical buildings is a reminder of the prosperity during the Middle Ages of these Norman grainlands.

West of the Eure the *Colline du Perche* and the *Colline de Normandie*, where the chalk is domed up above an ancient anticline extending east from the Cotentin Massif, form a water-parting in which the Oxford Clay is exposed and which throws off a number of streams, including the Orne, north to the Seine bay and southwards to the Sarthe and Loir, tributaries of the Loire. The Rille, the most westerly of these streams, draws a large number of tributaries from the *Colline du Perche*. Here the Tertiary rocks give wide valleys with woods and pasture.

With the basin of the Touquet, which debouches opposite Le Havre, the country changes, for the rivers have cut down to the chalk marls and beneath them into the Oxford Clay of the Jurassic series. This results in increased fertility of the valley slopes, as well as an increased dissection of the surface, the country, becoming more wooded, having more pasture, and therefore hedges, approximates to the *bocage* type. The plateau is reduced to narrow ridges of *limon*-covered hills.

The *Pays d'Auge* is the strip of country that marks the final transition from the Cretaceous rocks of the Paris basin to the narrow rim of Jurassic rocks that separate it from the Armorican Massif. In Auge the outcrop of Oxford Clay has been effectively eroded to form a broad vale by the river Dives between the serrated scarp edge of the Cretaceous plateau to the east and the Oolitic limestone plateau of Caen, which rises in gentle, cultivated slopes on the western side. The Dives enters the vale, where it widens into a broad, marshy basin, floored with alluvium, known as the Vallée d'Auge, and swings from side to side of the plain in sympathy with the general west to east graining of the land in this area.

The *Campagne de Caen* is the most westerly of the great limestone grain plains of northern France. A low plateau of Jurassic limestone, it stretches from south-east to north-west along the edge of the Armorican massif from which it is separated in the north-west by a narrow exposure of Lias clay. In the south it forms the Campagne d'Argentan, where the Dives rises in the

Monts d'Amain, whose highest point is 1,010 feet. At Falaise it forms a cliff wall overlooking an inlier of ancient slates, and farther north its escarpment is steep above the *bocage* land of the Orne basin. In the neighbourhood of Caen the Campagne narrows between the Lias Clays on the west and the silted estuary of the Orne in the east. It widens again between Caen and Bayeux to narrow finally to a high ridge of limestone which forms the coast of Calvados and ends in a bluff overlooking the banks and marshes of Les Veys. The Baie des Veys marks the termination on the coast (between Caen and the sea) of the Liassic vale which intervenes between the Jurassic limestones and the Armorican *bocage*.

Caen was a port in the eleventh century, at which time tidal waters produced sufficient depth in the Orne to make navigation possible. To-day it is only a port thanks to a canal which joins it to the sea by an artificial channel cut across the sand-spit which was threatening to block the entrance and which had diverted the river at least a mile to the east of its mouth. Ouistreham, on the canal, is the outport of Caen. It lies at the western extremity of the flat coast that terminates the *Pays d'Auge*. The natural function of Caen was to be the market for the varied types of agriculture resulting from the great variety of soils which characterize the junction of the Armorican Massif and the Paris basin—grain and sugar-beet of the Campagne; dairy produce cattle, and meat from the *Pays d'Auge* and Bessin; cattle, horses and dairy produce from the *bocage Normand* to the south and west; *cultures maraîchères* from the marshy estuaries of Orne and Vire; and fish from the multitude of little ports along the coast. The town has a natural nodality—the bridge port at the head of navigation, accessible by the straight roads driven across the limestone plateau from Paris, Le Mans, Mayenne, and Bayeux. It was greatly favoured by the Dukes of Normandy from the time of William the Conqueror, to whom are due its great conventual buildings.¹ Sea trade with England dates from that period. Wine was exported, wool imported, and a cloth industry grew up which brought the town great prosperity. Linen, velvets, and a variety of other textiles were made. In the seventeenth century Caen was already feeling the effect of the silting up of the mouth of the Orne, which prevented ships of 200 tons from reaching the mouth of the Audon—which forms the harbour—on the tide, and even much smaller vessels were apt to run aground. It was in 1838 that the canal, which reopened communication between Caen and the sea, was begun. The old harbour, at the mouth of the Audon, was turned into a dock, and

¹ Caen stone, which forms the subsoil of much of the plateau, was an important article of export to England, and appears in a number of ancient buildings.

an artificial port was constructed at Ouistreham by throwing out a couple of jetties. The port of Caen revived, exportation of agricultural produce, wheat, butter, and colza oil was resumed. At the end of the nineteenth century the exploitation of the iron-ores of Basse Normandie necessitated further improvements in the port. A barrage was constructed in the Orne below the town,

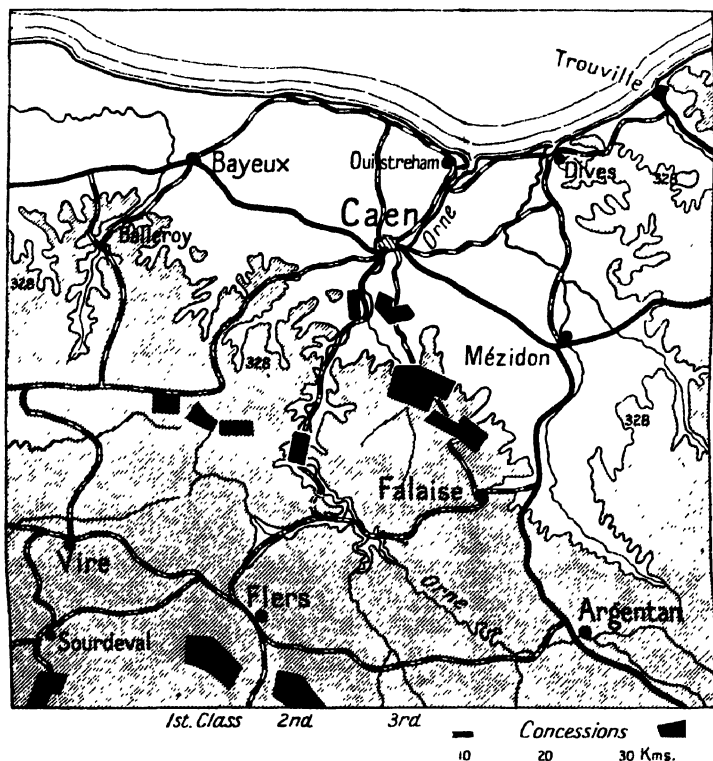


FIG. 31. THE PLAIN OF CAEN, SHOWING THE IRON CONCESSIONS ON THE EDGE OF THE ARMORICAN MASSIF

forming a basin which receives the traffic on the canal. Modern dredging apparatus and various other improvements have made the port adequate for the small type of mineral boat that carries ore to England and Rotterdam.

THE NORMAN IRON-FIELD. We have already mentioned the iron-ore of the Armorican Massif¹ in our study of that region. Let us now consider the relation of the ore deposits to the Campagne de Caen and to the port.

¹ p. 96.

Although insignificant compared with those of Lorraine, these deposits, owing to their proximity to the sea, have some importance. The ores occur in the Ordovician rocks of the Silurian system. They were formed at the base of oolitic limestones which were deposited in eroded synclines of the Armorican folds during a period of partial subsidence. They are found in an arenaceous or calcareous form at the surface of the Silurian sandstones. The sandstones have become impregnated with iron owing to water percolating through the overlying limestones and converting the carbonate of lime into carbonate of iron. These, where exposed through the erosion of overlying limestones, became converted into iron oxide or haematite. Where exposure to oxidation has not taken place the ore is calcareous. Iron occurs also in the Upper Lias beds at the base of the Great Oolite.¹ The iron is mined both in the Silurian sands and in the neighbourhood of Falaise in the Toarcian limestones of the Lias. The synclines are those of May, at Thury Harcourt, Urvile, stretching west from the Dives near Coulibœuf, and that of Falaise. The ore was worked in Roman times and throughout the Middle Ages. The development followed the normal course. Charcoal was used for smelting and hand bellows were used. Of course only the surface ore was tapped. Then the industry migrated to the valleys with the invention of the water-wheel and hammer. The industry gradually faded away with the movement of the iron and steel works to the coal districts. The ores began to be exploited on modern lines owing to the initiative of a German firm. Export began in a small way in the middle of the nineteenth century. By 1913 it had reached nearly 1,000,000 tons.^{2,4} Most of the ore used in France went at first by rail to Denain in the Nord department and Ysberg in Pas de Calais. The southern mines sent their ore mainly to the furnaces of the lower Loire. England and Germany were the chief consumers of the ore exported, English coal supplying the return cargo. Later, Ruhr coal came into competition with the English coal. A German firm was just about to begin smelting at Caen when in 1914 war broke out, with the result that a Le Creusot firm stepped in and set up coking-ovens and blast-furnaces there for the supply of armaments. Pig-iron was first exported in 1919. Stone-quarrying is still important, and the export of rolled flints from the coast to the pottery districts of France and England is still carried on.

The little Norman port is undergoing rapid transformation.³ It still retains its function as the agricultural market for the

¹ Maurice Gignoux : *Géologie Stratégraphique*, 1926, p. 277, fig. 57.

² H. Janau : 'The Iron Ores of Normandy' (S. G. M., 1925).

³ P. Gidel : *Caen, Dieppe and Cherbourg*, p. 31.

⁴ Between 1929 and 1937 the output of Norman ore fluctuated between 1.32 and 1.94 million tons.

products of the district—cereals and forage crops from the fertile Campagne de Caen, dairy produce, pigs and poultry and livestock from the impermeable *bocage* lands of Auge, Bessin, and Perche ; but the port is extending its quays and wharves down the canal towards Ouistreham and the water-meadows of the Orne valley are disappearing beneath the blast-furnaces, coal-dumps, and slag-heaps.

Fifteen miles north-west of Caen lies *Bayeux*, chief market for the marshy lands of Bessin on the river Aure. It is the centre of a lace-making industry, and has also pottery works of some note. Like Caen it serves the plains of Jurassic limestone with their rich covering of *limon*, the Norman *bocage* to the south-west, and the fishing-ports of the coast. The Aure passes north through Bayeux, as though to cut through the Oolite ridge of Calvados, but is drawn west through the Liassic vale which borders the Armorican Massif, picking up the Drôme and a large number of other streams from the impervious rocks of the *bocage Normand*. Much of this peaty vale has been drained and turned into *jardins maraîchères*. Isigny, where the Aure emerges among the polders of the Vire, is the outlet for the dairy produce and cider of Calvados and Bessin, and for the small fisheries of the coast. Port-en-Bessin also does a certain amount of coastal trade, and sends fish and shellfish to Paris as well as to the neighbouring market towns.

With the mouth of the Vire we reach the extremity of the sedimentary rocks of the Paris basin and their junction with the Permian rocks of the Armorican Massif, having transversed in less than seventy miles between Dives and Isigny the whole of the Jurassic exposures of the rim of the basin.

It is clear that the territorial name Normandy does not correspond to any definite geographical region, covering, as it does, part of the *bocage* of the Armorican Massif, and exhibiting, almost every type of limestone plain, from the bare, waterless Caux to the soft, marly limestones of the Oxford series south of Calvados, to say nothing of the reclaimed polder-lands of Auge and the lower Aure valley and the alternating sand-dunes and rocks of the coast. One of the most remarkable things about *Upper Normandy* is the effect of the Seine estuary in increasing the isolation of the agricultural life of the plateau.

In describing the various sub-regions that go to make up the Paris basin we have drawn attention to certain salient features which characterize the region as a whole. First the symmetry in

the exposure of the rocks that underlie the basin, in concentric zones, which gives form and unity to the whole area ; second, the variety of landscape due to the succession of exposures of rocks varying greatly in their reaction to erosive agencies in the building of land features and in the composition of soils, in the régime of streams, and so forth ; third, the trend of national lines of communication towards the centre at Paris and the consequent concentration of population, industry and commerce, and the strengthening by this accumulated energy of the centralizing forces themselves ; fourth, the uniform type of climate. These facts have been pointed out and dwelt upon time and again. There are other factors that are less striking perhaps, but geographically of great interest, on which more stress should perhaps be laid. The most characteristic physical feature of this basin of low relief is the constant repetition of the limestone plateau in every shape and form—high, rainswept, forested, as in the Langres ; low but compact, unbroken by valleys, waterless, soilless, almost devoid of vegetation, like parts of *Champagne pouilleuse* ; relatively high, sunny, windswept, dry and monotonous but with a good blanket of soil—the great wheatlands of Beauce and the Causse de Brie, the chalk *limon*-covered plains of Picardy and Normandy.

This wide distribution of limestone in the land-building of the country may be regarded as a factor of unity, in a sense, but locally, from the social point of view, it is a factor of isolation, for these plateaux, lying at elevations of 300–1,000 feet above sea-level, are separated from one another by steep-sided valleys and broad vales which, while encouraging life and movement along their courses, have presented, particularly in the past, but still emphatically to-day, a serious obstacle to inter-plateau communication by their steep, wooded flanks and marshy bottoms, and also, but more subtly, because they foster a life and interests within their almost hidden courses completely alien to the life of the peasant on the open plains, making him feel a stranger in the valley towns, whither he resorts only in company with his fellows on market days. The motor-car, with its capacity for surmounting steep gradients, is doing much to bring these settlements of the high plains into touch with one another and with the towns.

THE MIDDLE LOIRE

The region of the middle Loire belongs geographically to the Paris basin. Climatically it is a transition belt between the maritime climate of the north-west and the modified continental climate of the Central Massif. From the point of view of

communications it is intermediary, its rivers draining the border country between the Paris basin and the Central Massif, opening a narrow passage-way to the west across a somewhat thankless country of sandy and ill-drained plateaux. Hydrographically the Loire forms one of the two main drains for the rivers of the Central Massif, the Garonne being the other, but with all its great catchment basin it contributes little or nothing to the economic welfare of Central France. The impervious valleys of its head-waters throw off the rainfall rapidly, sending down sweeping floods to the plains, charged with vast quantities of coarse sand. As quickly they dry up during the dry weather, and the Loire is reduced to a miserable ditch, slinking hardly noticed among the vast sandy stretches of its flood-bed. We read of the great commerce of the Loire towns, and of Orleans in particular, during the Middle Ages; of the sailing boats that plied on the river, exchanging produce with the coast and with Auvergne. It was perhaps no worse than the land routes of the times, but with the improvement of these latter the traffic fell off and, with the installation of the railways, practically vanished. Mme. de Sévigné, writing in 1675, speaks contemptuously of its function as a carrier: 'Ils ont fait l'honneur à la Loire de croire qu'elle m'avait abîmée. Hélas! la pauvre créature, je serais la première à qui elle eût fait ce mauvais tour, je n'ai eu d'incommodité que parce qu'il n'y avait pas assez d'eau dans cette rivière.'¹

In Young's day barges and boats built in the Bourbonnais would bring down timber, wines, and brandy through Orleans to Nantes. Here they were generally broken up and the timber sold with the cargo.

Economically the region is almost purely agricultural, apart from the iron industry of the Nevers centre. No town on the middle Loire, except Orleans and Blois, has a population as large as that of Sevenoaks. There are a few manufactures—iron-works and porcelain works, which owe their existence to-day to the Loire lateral canal and to the railway. Orleans, owing to its important railway junction, has developed a number of small industries based for the most part on agricultural products.

THE MIDDLE LOIRE. Let us now follow the river in its excursion into and its retreat from the Paris basin, as it passes first through the Jurassic limestone plateau capped with Tertiary sands of Nivernais and Berry, then, after crossing the Gault Clay vale of Puisaye, as it enters the plateau of chalk, also covered with Tertiary sands and clays, that forms a southern continuation of Gâtinais, owing to the level surface and the impermeable

¹ Mme. de Sévigné writing to her daughter Mme. de Grignan in 1675.

subsoil, and finally in its great loop northward between the Forest of Orleans to the north and the Sologne to the south, where in the famous Val de Loire, it cuts a three-mile-wide trench into the low plateau of upper Tertiary rocks.

North of Nevers and the Vallée Noire (see p. 57) stretch the high Jurassic limestone plains of Berry, which are known, to the right of the Loire, as *Bas Nivernais*, and to the left as *Champagne Berrichonne*.

Between Nevers and Sancerre the Loire flows in a trench through the Corallian limestone, which spreads in a wide basin round Bourges. It is covered with broad sheets of Tertiary

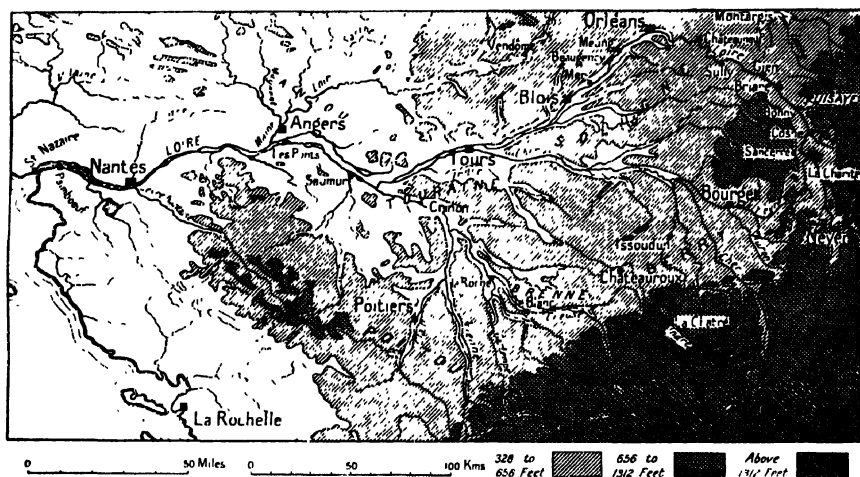


FIG. 32. THE MIDDLE AND LOWER LOIRE BASINS. NOTE THE FAULTED TRENCH NORTH OF NEVERS, AND THE PLATEAU NATURE OF SOLOGNE, BERRY AND POITOU

rocks, which produce a broken country with a light, sandy soil, porous, but fertile enough. Where the sand predominates, there is waste land with bracken and gorse, heather and broom, and patches of birch and oak wood. The Portland limestone forms the northern boundary of the basin, in the Sancerre hills rising to 1,300 feet and running west-south-west and east-north-east. Between these and the chalk plateau lies a narrow belt of Gault Clay, which forms the district of *Puisaye*.

In the plateau of Berry, or *Champagne Berrichonne*, the enclosed fields of the Vallée Noire give way to broad stretches of arable land, vineyards occurring where the limestones are exposed. The reddish soil bears rich crops of wheat, beet, and

maize for fodder. Goats are plentiful, their milk being largely used for making a well-known local cheese. Cattle are fed tethered on the edges of the clover or other fodder crop, as in Beauce, and if it were not for the vines one could easily imagine oneself in the open high plains of the Paris basin. The population is evenly distributed in small hamlets, which occur at intervals of about a mile. Large villages follow the edges of the Loire valley plain, which is a couple of miles wide, and small industries, metallurgical and ceramic, occur on the banks of the canal which skirts the left or western edge of the plain. The railway from Nevers to Orleans and the national road run along the edge of the plateau on the right bank. Towns lie on the river at the junction of important roads, from Auxerre and Montargis, e.g. Cosne, Bonny, Briare, and Gien. La Charité is a grain and wine market situated among the vineyards of the *Côtes de la Loire* where the Auxerre-Bourges road crosses the river. Levrux, La Châtre, Châteauroux, Issoudin are all market centres of this fertile limestone plateau, which, in type of scenery and in economic development if not in drainage and position, is part of the Paris basin. Sancerre is an old fortified city perched on the top of an isolated limestone hill which stands out in the Gault plain, inaccessible by the railway but served at a distance by a light railway. It is the centre of the vine district of Sancerrois.

BOURGES, the ancient capital of Berry, lies in the centre of a shallow basin in the Oolitic limestone, and is the converging point of the Yèvres and Auron. Its nodality is remarkable. Six main railway lines converge upon it. It is the centre of a dozen national roads. It commands the main road from Nantes via Tours and the Cher valley through the Autun gap to Dijon, as well as the three main routes southwards across the Massif to Toulouse, Nîmes, and St. Etienne. Its population, over 44,000 if the suburbs are included, has increased slightly during the last hundred years, in which it differs from many agricultural centres. This is due mainly to the military arsenal established there. Besides its blast-furnaces and foundries Bourges has engineering, tanning, and linoleum works. The town has an important strategic position. It stands in the direct line of fortresses—Metz, Bar-le-Duc, Troyes, Auxerre, and had an enhanced military significance during the period when Metz was in German hands. The bluff on which the old citadel stands is almost encircled by the Yèvres and its tributary the Auron, and is crowned by the cathedral of St. Etienne, which, with its magnificent façade and its rich interior, is a witness to the agricultural prosperity of the region of Berry, which has continued from Gallic, through Romano-Gallic and medieval times. The Roman

walls, which are still standing, remind us of its importance as a strategic position, both locally and in a wider sense from pre-Roman to modern times.

From Cosne the Loire flows north through a broken, rolling country, in which lower Tertiary sandy clays overlie the chalk which is exposed in the valleys. Small towns lie on the steep slopes. Briare, at the junction of the Briare canal, has iron-works, the ore being brought now from Novéant in Lorraine. It also has large ceramic works where porcelain and glass buttons and ornaments are made. Gien, where the railway from Montargis crosses the Loire, also has potteries. Local sands and clays supply the raw materials for these industries. The district is supplied with coal by rail and by the Loire and Briare canals. As in the Pays d'Othe, forests cover the dip slope. The scarp is indefinite and wooded and the dip slope is covered with woods. The impermeable soil is naturally level and ill-drained, and large, shallow lakes abound as once in Gâtinais.

Just below Cosne the Loire leaves Nivernais, flowing north as though to join the Seine, and may at some period have done so, but now sweeps westward in a bold curve, cutting off the great flat-topped plateau of *Sologne*, composed of Tertiary sands and clays, overlying chalk, and studded also with lakes. The whole of this country is green and well-wooded and, with its vines and orchards, its woods, parks, and châteaux, its broom-covered heaths, it forms a pleasing contrast to the more fertile arable plateaux of Beauce and Berry, which lie to the north and south. The river has cut a broad trench through the Tertiary covering which masks the chalk. This trench is now filled, to a depth of thirty feet, with recent alluvium, which contains evidence of the origin of the river in the volcanic areas upstream. It forms the famous *Val d'Orléans*. The sides of the present flood-plain give back in broad terraces of alluvium of more or less recent date, rising to 130 and 200 feet above river-level. They owe their origin to oscillation in the relative levels of sea and land.¹

The river swings from side to side of the broad, level plain, braiding its course, piling up great banks of sand that it has torn from the floors of the Tertiary basins in its upper course. In times of flood it converts areas of the flood-plain into vast lakes. 'One arch is sufficient for the passage of its waters when it flows at a depth of two or three metres only above its sandy bed ;

¹ Four terraces of quarternary deposits correspond to the four principal erosion stages (300-330, 180-200, 100-130, 50-70 feet) of the great valleys, in which equilibrium has been reached in the cycle of erosion and deposition, and where the earth is practically stable, a stability probably reached during the Upper Pliocene period.—E. Chaput, *A. de G.*, 1919, p. 98.

fifteen arches are not sufficient when it rages through them on a level with their key-stones.' ¹

Sully-sur-Loire and Olivet on the south bank, Châteauneuf, Meung, Beaugency, Mer, and Blois stand on bluffs of the plateau overlooking the flood-plain.

Orleans, which also lies on the right, or north, bank, is a bridge town. 'From the steeple of the cathedral of Orleans the prospect is very fine. The town is large and its suburbs of single streets extend nearly a league. The vast range of country that spreads on every side is an unbounded plain, through which the magnificent Loire bends his stately way, in sight for 14 leagues, the whole scattered with rich meadows, vineyards, gardens, and forests.' ² The town has increased by 5,000 during the last half-century, and a broad belt of houses now stretches outside the Boulevards, which represent the old fortifications. The population in 1936 was 66,013. There is not a great development on the south side of the river, owing partly to the great breadth of the stream. The present railway bridge, which crosses with the help of an island at the eastern end of the town, is near the site of the old town bridge, whose engineers also availed themselves of this. The present road bridge is 1,092 feet long.

Orleans is the market centre for the wheat-lands of Beauce and Berry. Much flour-milling is carried on in the departments of Loiret and Loir-et-Cher. Orleans and Blois have developed the manufacture of biscuits and chocolate and other confectionary. Other industries connected with local agricultural products are vinegar-making, which dates back to the Middle Ages, and is a by-product of viticulture, and tanning, in which the products of the Sologne pastures and forests are used. The manufacture of woollen blankets is another ancient occupation of Orleans, which has its origin in the pastoral and agricultural hinterland of the town. Further, Orleans has metallurgical and light engineering works. It has iron and copper foundries and it manufactures agricultural machinery of all sorts, and gas engines for the farmlands of Beauce, Sologne and Berry.

In *Sologne*, to the south, there is very little ploughland on the cold, water-logged soils of the Tertiary clays, but many large vineyards cover the valley slopes, scientific drainage and afforestation ³ are converting the dreary, bare, lake-studded plateau of Sologne that lies in the bend of the Loire, with its malarious, scrofulous, wretched inhabitants, into a comparatively healthy

¹ O. Reclus : *Géographie Rapide*, p. 49.

² Arthur Young : *Travels in the Kingdom of France*.

³ The woods of Sologne and those of the Forêt d'Orléans north of the river are exploited for pit-props and a number of minor industries such as the making of *parquet* flooring, barrels, brooms, etc.

and prosperous area. The shallow lakes and swamps due to the impermeable soil have been to a large extent drained, and liming of the soil and enriching by fertilizer is gradually reclaiming the land. Romorantin, the former capital of Sologne, has old and important cloth works.

TOURAINÉ. At Blois the river leaves the Upper Tertiary plateau to enter the more sandy area of Lower Tertiary deposits in the Gâtine of Touraine. Through this it trenches its wide valley, which from Blois is protected on the north from the floods of winter by a great dike faced with masonry. This dike carries the railway and is continuous all the way to Angers. That part of the broad flood-plain thus protected is used for market-gardens and nursery-gardens, and is very productive.

The situation of *Blois* on the north bank is very like that of Orleans, but there is no island here to facilitate bridging. The whole town lies on a slope, and the suburbs rise steeply to the edge of the plateau. This steep descent to the bridge is a constantly-recurring characteristic of the plateaux of northern France, and is a direct result of the predominance of limestone in the architecture of the land and of the earth movement which caused the rivers to etch their way into the plateau. The town must be connected with the bridge, and it must be near the foot of the slope if it is to obtain water without too great difficulty. Blois is linked by an important line with Bourges and the upper Cher and Loire valleys.

In its passage through Touraine, the Loire is accompanied in its broad valley by the Cher, Indre, and Creuse.

We have seen how these rivers quit the Central Massif to cross, in the department of Indre, the narrow belt of Lias Clay which we encountered in the Vallée Noire. Here the little bridge town of Argenton-sur-Creuse, on a projecting shoulder of the succeeding Jurassic limestone belts, marks the site of a Roman station and a medieval stronghold, guarding the crossing by the main north and south road of the western part of the Massif. Le Blanc, in the *Pays de Brenne*, occupies a position similar to that of Bourges, but in a much smaller basin of the limestone plateau. It too was a fortified place with a château in the twelfth and thirteenth centuries, profiting by the limestone bluffs overhanging the broad, flat-bottomed valley of the Creuse. Enormous stretches of Tertiary deposits cover most of La Brenne, which lies at over 330 feet above sea-level, except where the rivers have eaten them away, as they carved out their broad valleys, and exposed the underlying limestone. As in Sologne, the level surface is studded with lakes, and is sparsely populated. The woods of oak furnish planks for boarding and constructional

purposes which are exported to England. There is much cattle-rearing, and tanning is a major industry as throughout Touraine.

The valley of the Loire widens at the junction of these valleys that open from Berry, and all the sunny slopes are under the vine. The wash-down from the chalk slopes, for the Tertiary rocks are now but a capping, give a rich vine cultivation on the valley sides. Bourgueil, on the north bank of the Loire, Chinon on the Vienne, and Vouvray, a few miles above Tours, have all given their names to well-known vintages. Excavations in the chalk cliffs that shut in the valleys are utilized, as in Champagne, for storing and treating the wine.

Tours, once the capital of Touraine, lying on the south bank between Cher and Loire, is supported by the traffic brought by its great bridge, 1,423 feet long, which carries the Paris-Bordeaux road across the river, and the abundance of the agricultural products of the district, favoured by the mildness of the climate. With its suburb of St. Symphorien it covers both banks. It supplies the countryside with agricultural machinery.

Forty miles below Tours lies Saumur in Anjou, the centre of a very noteworthy wine industry. Although at the limit of vine cultivation, Anjou has some very good vintages, making chiefly white wines. Sparkling wines of the Champagne type are made at Saumur. The vineyards occupy the slopes of the Loire valley and of the tributary valleys of the Thouet and Layon.

THE LOWER LOIRE

At Les Ponts, thirty miles below Saumur, the Loire enters the Armorican Massif. The vast plain of recent alluvium and the great *levées* come to an end. The high rim of the Cretaceous and Tertiary plateaux drops to a lower level and the edges of the valley draw in. The river continues to wind, however, in a flat-bottomed flood-plain, splitting into numerous channels, which surround low, green islands. The river Maine comes in on the right, accompanied by road and railway from Angers. It is noticeable that the red tiles have disappeared now and houses are all roofed with slate. We have already described this section of the Massif in Chapter III, but in order to explain the position of Nantes we must remind our readers that the trend of rock features here is from north-west to south-east, following the lines of the Armorican folding and faulting. The Loire cuts diagonally across the various exposures: first the Carboniferous basin of Varades, then the schists of Champdoctaux, then it widens its valley in a soft belt of slates before it cuts through a band of crystalline schists just below Nantes.

NANTES. Nantes, with a population of 183,456, lies on the right bank of the Loire at the confluence of the river Erdre. Here the Loire divides into three main branches, enclosing two large islands and a number of small ones. This facilitated bridging. The original settlement occupied the eastern angle between the Erdre and the Loire, and stood on a low bluff overlooking the rivers. Here stand the castle and the cathedral to-day. The modern town stretches for four miles along the Loire on either side of the Erdre, covers the smaller islands, and is rapidly spreading on to the larger ones in the south. On the south side of the Loire the valley of the Sèvre Nantaise leads through Vendée, giving access to Poitou. The east and west valley of the Loire and the valleys of the Erdre and Sèvre conduct important cross-roads, converging at the bridge. This was the *raison d'être* of Nantes, the port of the Gallic tribe of the Namnetes. The Romans carried a road from the Rhine to this point, via the Belfort gap, Autun, and the Loire valley. During the Middle Ages the port formed an entrepôt between Brittany, Vendée, and the Ile de France. It traded with the northern ports of Europe. Wool, wine, and wheat were the chief commodities that came to it for export. With the founding of the French colonies it developed an important circular trade in sugar, rum, and slaves, like the port of Bristol. The abolition of the slave trade was a severe blow to the port, and the introduction of beet sugar only aggravated, by introducing a competitive trade, the disasters due to the Napoleonic wars. Gradually the sugar trade revived, but never resumed its former importance, though a by-product—that of molasses fertilizer—was some compensation. The later development of Nantes is closely allied to the coastal activities of Brittany. The port receives oils for the sardine preserves, and developed incidentally soap factories, and in more recent times the canning of fruits and early vegetables, from the immediate hinterland of the Loire plain, has been an important development. A more recent activity has been that of the metallurgical industry, based originally on the iron-ore of the Segré basin, and developed later on Spanish ore imported by sea and English coal. Iron-ore from Anjou is exported. There are large ship-building yards on the left bank, employing about 4,000 men, and iron and steel-works at Nantes and six miles below at Basse Indre and Couëron, employing several thousand men. The Nantes works makes steel castings, mainly for naval construction.

ST. NAZAIRE. In the last half-century the port facilities of Nantes have proved entirely inadequate for modern conditions of transport, in spite of continuous effort to keep pace with the times. Large boats had to be lightened at Paimbœuf, thirty

miles downstream. Then this port became too difficult of access for modern vessels, for the Loire, on leaving Nantes, cuts through a belt of crystalline schists, as far as Couëron, and enters a broad depression filled with alluvium, which has been hollowed out of the soft shales and slates to form a great estuary, but in which the currents are unable to scour sufficiently deep channels. This depression is shut in on the south-west by a broad belt of granites and schists, which cause the estuary to narrow before it debouches into the sea. On either side of this mouth rocky headlands stand

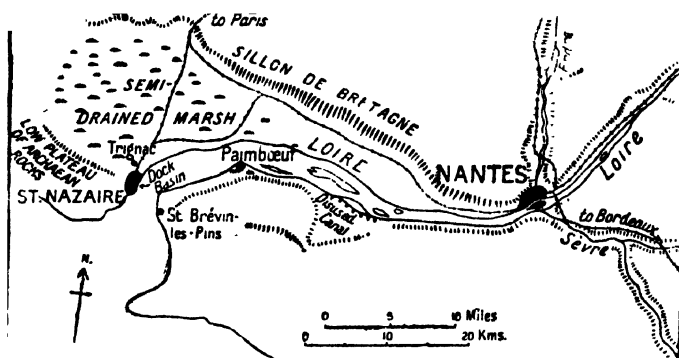


FIG. 33. NANTES AND ST. NAZAIRE. NOTE THE ESTUARY OF THE LOIRE EXCAVATED IN THE SOFT SLATES BETWEEN THE LOW PLATEAUX OF ARCHAEOAN ROCKS. NANTES AND ST. NAZAIRE ARE PLACED AT POINTS WHERE THE HARD ROCKS APPROACH THE WATER.

out, and it is in the shelter of the northern of these that the out-port of St. Nazaire has been constructed. The port lies in the shelter of a projecting headland of granite, behind which, owing to faulting, a depression, in which Silurian slates have been preserved, has been eroded and partially drowned. In this soft material two dock basins have been excavated with all the modern equipment, including elaborate railway sidings.¹ The town lies behind the docks, which run north and south and open to the east and south. The southern entrance is protected by two long moles forming an outer harbour which opens on to the Grande Rade, where there is good anchorage in from six to nine fathoms of water. Apart from the work engendered by the port, St. Nazaire has important ship-building yards at Penhoët. Here steel ships are built and there are naval and marine workshops, as well as works for making steel rails. The metallurgical works of Trignac, north of St. Nazaire, have smelting works and 175

¹ The larger basin was excavated in 1881.

coking ovens,¹ steel works, rolling-mills, sheet iron and steel plates for naval construction and guns which go to the yards of St. Nazaire and Nantes, to Brest and Lorient, and farther afield. The heavy imports consist of coal from South Wales, iron-ore from Spain and Sweden, and timber from the Baltic. In addition, wine from North Africa and Rumania is imported for blending. Wine, brandy, and pit-props from the Touraine and Aquitaine hinterland are exported. The population of St. Nazaire had grown by 1936 to 42,364.

The port of Nantes-St. Nazaire, for the two ports are complementary, is especially the port of the south Armorican hinterland. Its railway communications with the upper and middle Loire provide an extension to this hinterland, which would be of still greater value if the Loire were navigable for large barges and could carry coal in bulk, like the Seine and its tributaries. St. Nazaire serves the growing industry of Nantes, is an important port of call, owing to its deep water and coaling facilities, and competes for the traffic with the Americas with Le Havre and Bordeaux, particularly the latter, over which it has the advantage in railway communications. Nantes, however, did not give up the struggle after the development of St. Nazaire. Communication with the sea had been improved by the diking of the river in the section above Paimbœuf and the construction of a ship canal on the south side of the estuary. This was finished in 1892 and was navigable for vessels drawing eighteen to twenty feet. Modern engineering science has made it possible to dispense with the use of this canal. By the building of groins and other controlling works, the waters are forced to scour their own channel, and vessels drawing twenty feet can now reach Nantes at any time of the tide, which rises sixteen and a half feet at the springs.

Paimbœuf on the south side specializes in the import of phosphates and pyrites for local works, and exports super-phosphates.

Nantes to-day aspires to be the terminal of a great traffic route which shall link Switzerland with the sea. It is not likely that the Loire will play any important rôle in this.² One of the few main west to east railways of France passes through Nantes—for south of the Loire valley there is no natural route-way. In fact, it provides the only natural through route, except that from Strasbourg. Nevers is an important junction, for from this point the main west to east line splits up into three parts which pass to Basle, Geneva, and Lausanne.

¹ *Région Economique*, Paris, 1924, p. 64.

² See p. 467.

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CHAPTER V

NORTH-EASTERN FRANCE—PICARDY, ARTOIS AND FLANDERS

THE edges of the ancient Block Mountains that bound the Paris basin on the east sweep round north-westwards in a bold curve, to terminate in the western extremity of the Ardennes. The curve is continued to the coast beyond the depression of the sill of Artois by the rising chalk lands of Upper Boulonnais. Eastwards these chalk uplands dip steeply to the plain of Flanders; westwards they continue in broad, rolling plateaux, drained, not to the Seine but by the Somme and Canche to the coast. The *pays* of Picardy, Artois and Flanders are linked industrially and commercially with the Flemish industrial region and with Paris as well as with the ports of Calais, Dunkirk and Boulogne.

THE SOMME, PICARDY. The Somme rises south of Cambr sis on the dip slope of the chalk, at about 230 feet above sea-level and follows a winding course to Amiens, whence it follows a synclinal depression north-west to the Channel. It flows through a gradually widening, flat-bottomed, marshy valley. Although the rainfall is heavy,¹ the water, except in very heavy downpours, percolates slowly and reaches the stream mainly by springs on the lower slopes and in the valley bottom. This means that the stream brings down very little detritus in suspension, and there is but little silt deposit in the flood-plain. Hence the eroding power of the Somme is small, and hence also there is a tendency to the establishment of peat-forming vegetation in the streams and flood-plain. The river has a lateral canal, which accompanies it almost throughout its course, hugging generally the left-hand edge of the flood-plain. Villages and small towns follow the river, but larger settlements cover the low plateau on either side of the Somme. They are rarely more than a mile apart and are connected by a network of roads. Their population varies from a couple of hundred to about 4,500. Roye, near the source of the Aire (tributary of the Somme) at the intersection of important cross-roads, which traverse the upland from Noyon to Amiens and from P ronne to Clermont, is also on the railway, which accounts for its comparatively large number of inhabitants. The chalk plateau south of the river, is known as La Santerre. It is a rich

¹ See p. 19.

grain and sugar-beet country—the sugar factories, as at Roye and Ham, and the brick-yards testify to the depth of clay, loam, and loess upon the chalk.

The upper basin in the districts of St. Quentin and Vermand

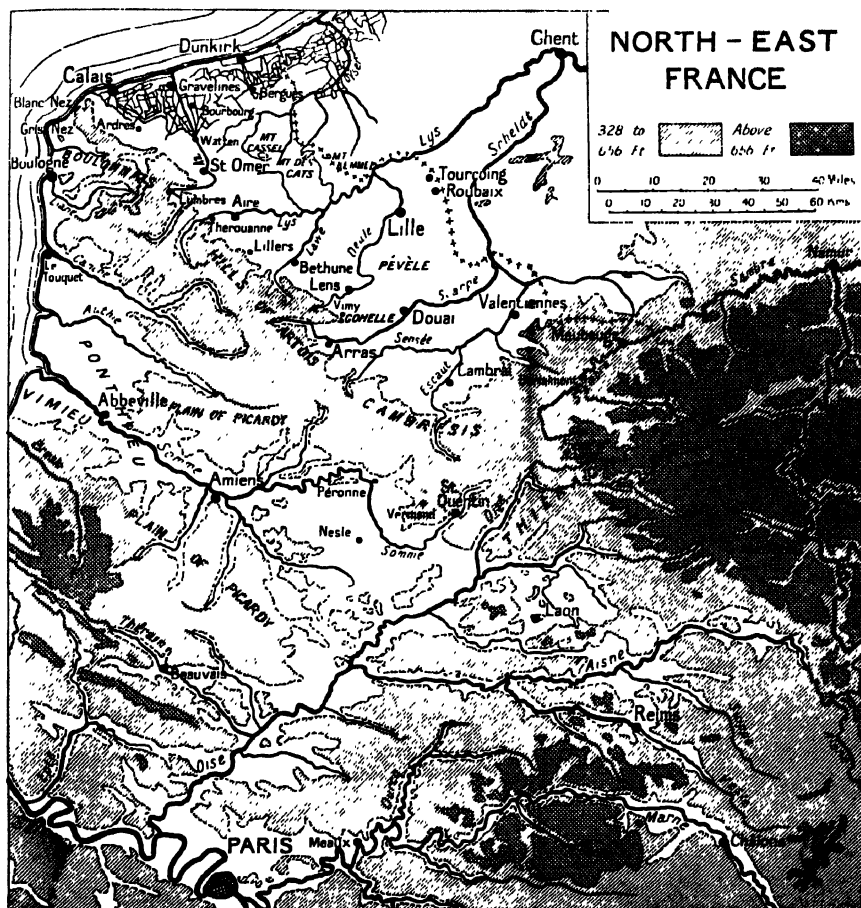


FIG. 34. THIS MAP BRINGS OUT THE RELATION OF THE PLAIN OF FLANDERS TO THE SOMME AND OISE BASINS. NOTE THE NARROWING OF THE DIVIDE BETWEEN ARRAS AND AMIENS, CAMBRAI AND ST. QUENTIN.

had a flourishing cotton textile industry, exhibiting extraordinary variety, which was completely wiped out in the 1914-18 war. It was re-established on modern lines however and St. Quentin is the centre of an important manufacture of '*spécialités*', piqués, reps, poplins, machine embroideries, etc., carried on in the

neighbouring villages of the plateau. Bohain, three miles from the source of the Somme, makes all kinds of fancy tissues. Both centres are in close touch with Paris.

At Péronne the Somme turns west, after receiving a couple of small tributaries, and begins a series of incised meanders, which continue to within a few miles of Amiens. Péronne lies below the ruins of its thirteenth-century castle. Its population now numbers just over 4,000; fifty years ago it was nearly 5,000. As a fortress the strength of its position lay in the marshy stream valleys that protect it on three sides. Below Péronne the valley of the Somme becomes wider and its walls steeper. On the right hand (north) the plateau rises to over 330 feet. Dry, branching valleys converge on the outer curve of each meander, where, in almost every instance, a village commands the converging roads. In the neighbourhood of Bray the flood-plain begins to be dotted with ponds. These are formed, some by the excavating of peat, some by the process of damming the river to obtain a head of water for a mill-wheel.

South of the river a Roman road passes straight as a die across the plateau from Vermand to the Aire bridge near Amiens, avoiding, for the most part, the villages, which seek the slopes of the upper dry valleys for the sake of water supply. This plateau, once covered with fertile loam and clothed all over with prosperous villages and hamlets, each surrounded by its orchard, with the church spire showing above the trees, is slowly recovering from the terrible ploughing and harrowing worked by the shells in 1916-18. Its mangled villages and churned-up subsoil will, in some places, never be brought back to use and habitation. Vast craters and crude, infertile exposures of chalk have taken the place of the fertile loamy fields. Where the covering of *limon* was thick, on the lower slopes the farmer has been able to cover the scars of war with fields of grain; but the reconstructed towns and villages bear little resemblance to their former selves. The war of 1914-18 has made a crude break with the past, and there is a certain incongruity in the aspect of the reconstructed settlements, as of a peasant girl when she exchanges her native costume for the garb of the town.

Eight valleys converge in the neighbourhood of Amiens, six of them carrying railways. Two—the upper and lower Somme—have canals. The citadel of Amiens stands on a bluff overlooking the flood-plain, which is built over within the town and intersected by a network of canals through which the river water is distributed. Immediately without the town the flood-plain is given over to *hortillonnages*—market-gardens conjured by some magic of industry from the peat bogs. A double *ceinture* of

boulevards marks the old fortifications which once warded the city. Manufactures have invaded the low quarter of the town, which was less desirable than the upper part for residential purposes, and the canals serve many purposes in the industrial life of the city. A broad *chaussée* crossing the low town connects the citadel on the north of the river with the old hill city on the south. Here was the crossing of the river which gave the old Roman station its significance. Below Amiens, fortified by the waters

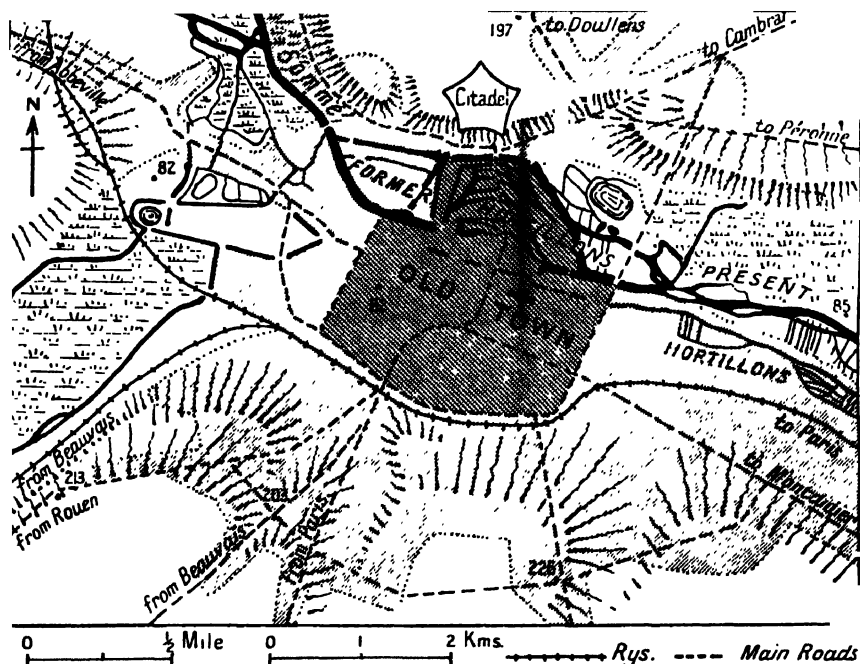


FIG. 35. AMIENS. NOTE THE DYKES THAT INTERSECT THE MARKET GARDENS AND SERVE THE PURPOSES OF DRAINAGE, IRRIGATION AND COMMUNICATION—THE OWNERS VISIT THEIR GARDENS IN PUNTS.

of the group of affluents that join it near the city, the river has widened its marshy flood-plain, and in Roman times, when the tidal waters ponded back the river, it must have been very difficult to cross. The new residential quarter lies outside the boulevards in the south and along the slopes of the valley on either side of the citadel to the north.

The magnificent Gothic cathedral, which, unlike the Château de Péronne, was but slightly injured in the 1914-18 war, bears witness to the medieval importance of the market town and industrial capital of Picardy. To-day Amiens is once more a

flourishing textile centre, making cotton cloth and Utrecht velvet, as well as the chief market for the rich agricultural plateau of Picardy. Its population has grown considerably since the war of 1914-18, reaching 88,961 in 1936.

Below Amiens the low plateau of loam-covered chalk rises gradually. The river, flowing against the slope of the land, trenches deeper; the scarped edges of the flood-plain become higher and more abrupt as the plain widens. Every three or four miles a *chaussée* with a bridge traverses the valley, a pair of large villages stand at the bridge-heads where the cross-roads, descending steeply from the plateau-tops at about 300 feet above sea-level, cut the lateral roads that follow the foot of the valley slope on either side. Roads, rail and canalized river (for the Somme is canalized from Suilly Lorette) follow the valley to Abbeville and the coast, but the great trunk roads, the *routes nationales*, leaving Amiens, run north to Dunkirk, north-east to Cambrai and the Rhine, and south to Paris, for Abbeville is no longer a port at the head of a tidal estuary. It is an old fortress like Péronne, lying also in the flood-plain on the drift gravel, and is situated at a point where the tidal river divides into two arms and could be readily bridged. The estuary extended to Abbeville in earlier days and was capable of accommodating ships of considerable size. Moreover, the town was then an important route centre, roads from Paris, Rouen, and Brussels converging upon the port, which had an active trade in wool and a cloth-making industry. Like Amiens, it is threaded by a number of canals which facilitate the development of industry. The port became nearly extinct owing to the progressive silting of the estuary; now, however, the river is locked at St. Valéry, eight miles downstream, and a depth of eleven feet is afforded by the canalized river at Abbeville. It receives some Baltic timber via St. Valéry, which has taken its place as a seaport and does a certain amount of coastal traffic, exporting phosphates to Brittany. To-day a strip of marshy land, the *Marqueterre*, separates the edge of the low chalk plateau from the sea, stretching from the mouth of the Canche to Ault near the mouth of the Bresle. It has been reclaimed gradually as the sea receded, like the coastal strip of French Flanders; but, cut off from the hinterland by the chalk escarpment, it has not developed agriculturally or industrially and would still be just the haunt of a small fishing population, but for the modern *bain-de-mer* development at Le Touquet, Paris Plage, Merlemont Plage, and Berck Plage. Le Touquet has a resident population of 3,400 and boasts a dozen hotels. The sandy hills behind the *plage* are wooded and the watering-place is laid out along the sea front in

modern rectilinear fashion. There is little to distinguish it from the Flemish watering-places.

The broad, marshy valley of the Somme has throughout history been a vital line of defence. Its crossings have been guarded by Roman stations, by medieval castles, and by modern trenches. De la Blache refers to it¹ as 'cette ligne de places, tant de fois disputée, qui fut le front de résistance de la monarchie française, le rempart compact dans lequel il ne pouvait se produire une brèche sans que l'émoi gagnât tout le royaume.'

North of the Somme, and parallel to it, the *Authie* and the *Canche* flow in similar deep trenches, also due to synclinal folding and faulting. Both valleys, like that of the Somme, are silted and have developed floors of peat. Montreuil-sur-Mer, on the Canche, with its medieval fortifications, has, like Abbeville, been deserted by the sea and is no longer a port. The incised valleys, with their wooded slopes, marking the exposure of the cold, wet clay-with-flints, have, at all times, made intercommunication between the agricultural folk of the partitioned plateau somewhat difficult. This semi-isolation is reflected in the fact that each river-bound block of plateau is regarded locally as a separate *pays*, although there is little in the general aspect of the country or in the occupation of the people to warrant such a distinction. North-east of the Somme is the *pays* of Ponthieu; south-west is that of Vimeu; beyond, south of the Bresle, lies the *Pays de Caux*.² Here, although the general form lines of the chalk continue, the steep coastal cliffs, the short, narrow valleys, and the much greater extent of forest do differentiate the land from the chalk districts farther north. This is because the clay-with-flints becomes much more frequently the surface formation. With its greater capacity for absorbing and holding water, its heavy, sticky nature, it makes a soil that demands more effort than the loams of Artois to the north of the Authie. Artois differs also from Picardy in that, instead of being formed of a series of broad, flat-topped plateaux, it is striated from north-east to south-west by a multitude of valleys, dry or otherwise, trending at right-angles to the main synclinal streams, i.e. consequent to the dip of the strata. The result is that water is more plentiful³ than in Picardy and the population more scattered.

BOULONNAIS. The chalk plateau of Picardy, with its parallel south-east to north-west furrows, rises gently to a culminating ridge in the hills of Artois. This ridge terminates north-west in

¹ P. Vidal de la Blache: *Géographie de la France*, 1908, p. 98. ² See p. 142.

³ Artesian wells derive their name from north-eastern Artois, where deep wells were sunk in the Middle Ages.

Boulonnais.¹ Here begins the south-east section of the eroded summit of the anticline which extends through the Weald of Kent, Surrey, and Sussex. Bas Boulonnais thus forms a miniature weald, bounded by a steep chalk escarpment north, east, and south-east and open to the sea on the north-west and south-west. The downs above the escarpment are distinguished as Haut Boulonnais. This downland continues without interruption into the lower, rolling country of Artois.

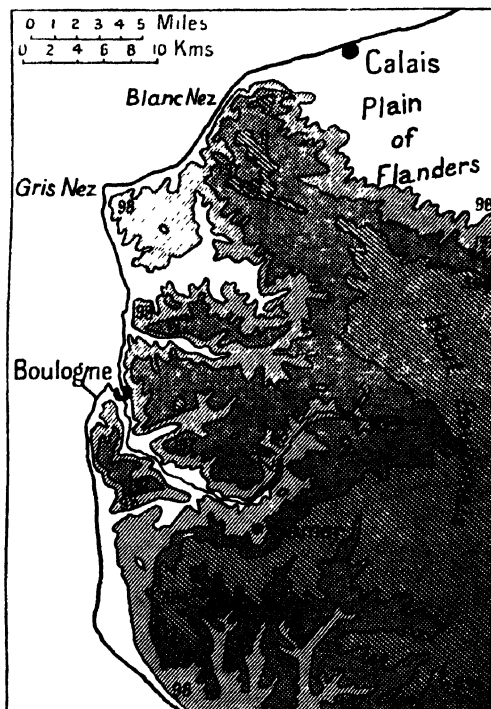


FIG. 36. THE WEALED OF BOULONNAIS

The contrast between Bas Boulonnais and Haut Boulonnais is very striking. In the former the clays of the Jurassic and Lower Cretaceous rocks form a low *bocage* country at the foot of the chalk escarpment, beyond which the Jurassic limestones form a dissected mass of upland which terminates at the coast in the jutting headland of Gris Nez. Cape Blanc Nez marks the end of the ridge of chalk which continues in a narrow zone from Haut Boulonnais and is truncated by the sea. The chalk and limestone bluffs are familiar to those who visit our own coasts between

¹ See p. 134.

Deal and Dover, whence their scored cliffs and turfey slopes are often plainly visible across the eighteen odd miles of shallow sea. The whole of Bas Boulonnais is streaming with water from the foot of the chalk scarps, and the vales are covered with well-watered pastures which feed dairy herds and horses. Where the clays reach the coast there are salt marshes fringed with sand-dunes.

Boulogne, at the mouth of the little river Liane, has outgrown its small estuarine harbour and depends now on an outer harbour protected by a mole and providing an anchorage in forty feet of water at *L.W.O.S.T.* A new harbour is under construction for passenger services with England. The chief imports of Boulogne, apart from travellers, are coal, pit-props, and timber, iron and manganese-ore, jute, machinery, hides and skins, and rubber. The exports are mainly manufactured articles, motor-cars, silk, and woollens. Wine, fruit, vegetables, and flowers from the south are also exported in large quantities. There was a considerable emigrant traffic from Boulogne to the Americas before 1914.

Cement-making and the manufacture of pottery are both occupations that derive from the peculiar structure of the weald of Boulonnais, where sandstone, limestone, chalk, and clay are all exposed over a comparatively small surface. The clay comes from the quarries at Nesle, near Samer. Bricks and tiles, both ordinary and fire-resisting, as well as sanitary fittings, are made. The chalk marl (Cénomanien) and clay of this formation provides the raw material for the fabrication of 'Portland' cement, which is carried on at Boulogne and throughout Boulonnais. The industry was introduced into the district about the middle of the last century, when a portion of the limestone cliff and foreshore was acquired for the purpose. To-day about 60 per cent of the total amount of cement made in France is produced in Boulonnais. The fabrication of steel pens and of pencils in Boulogne appears to be due to the inspiration offered by the importation of these articles in large quantities and at a great profit from England, and has no other local stimulus. The steel for the pens has to be imported from Sheffield and the graphite is also of foreign origin.

Apart from the cross-Channel services, the principal activity of Boulogne is found in its fisheries. Boulogne is the Grimsby of the Continent, one-tenth of its population being employed in fishing. The large trawling firms employ about 5,000 fishermen and own some 200 trawlers. Several thousand hands, men and women, are employed in curing, salting, and packing the fish, and in the allied industry of making fishing-nets. In 1937 the port dealt with over 86,000 tons of fish: more than a quarter of the total for France.

ARTOIS. South-eastward from Boulonnais the ridge of Artois dips gradually before it rises towards the Ardennes, forming a low sill in which the elevation does not exceed 400 feet. Over this threshold in the Eocene period the seas of the Paris basin and of the Brussels basin communicated. To-day it forms one of the most important gateways of Europe. To the north-east it drops abruptly to the plain of Flanders in the Brussels basin, to the south-west it dips gently to the basin of Paris.

FRENCH FLANDERS

The Brussels basin is an extension of the London basin, just as the uplift of Artois is a continuation of the Wealden anticline. As in the London basin, the chalk underlies the whole area of the basin of Brussels, cropping out on the rims and dipping, at first at an acute angle and then gradually northwards and north-eastwards. The ridge of Artois forms the south-western rim. In the south and south-east the chalk is folded against the ancient Massif of the Ardennes. The floor of the basin slopes towards the sea and towards Antwerp. Only the south-western extremity of this region lies within France. The departments of Nord and Pas de Calais comprise the eastern slopes of the hills of Artois and a narrow strip of the Flanders plain. The upfolded chalk rim is accompanied in the west and south by a synclinal depression, whose presence is reflected geographically in the zone known as *Gohelle* and *Pévèle*. The down-folded chalk trough has been filled with sandy Tertiary deposits. Associated with this synclinal trough, but in the deep-seated strata lying below the chalk, Carboniferous rocks that faulting has brought near to the surface bear the coal seams of the French and Belgian coal-field.

Beyond the narrow syncline the chalk rises close to the surface, then dips gently towards the sea, disappearing from view beneath a succession of Tertiary sands and clays laid down now under marine, now under lacustrine, and again under lagoon conditions. Certain of these deposits were limited to portions of the Brussels basin, others covered the whole basin, others overlapped into the Paris depression. Tremendous erosion exposed the various Tertiary strata in a series of concentric rings, which, had the rocks been of a resistant nature, would have terminated each in an escarpment, as do the limestone exposures of the Paris basin. Owing, however, to the non-coherent nature of the deposits which were formed from the detritus of the ancient plateau to the south of granite, sandstone, and shales, laid down in shallow seas—escarpments there are

none, and the passage from one outcrop to another is marked rather by differences of vegetation than by differences of land form and relief. Nevertheless, the clayey sands do rise slightly above the sandy clays, even in the regions of very low relief.

Round the rim of the basin the long, low spurs of chalk drop gently from a height of about 250 feet at the foot of the plateau to about 130 feet, to form a slightly elevated zone about ten miles wide overlooking the Flanders plain. This continues into the Pévèle, where the sands and clays cover the chalk. Beyond this zone again four main belts are distinguishable as geographical features. In the south and south-west a narrow strip of sands overlies the chalk, where it emerges from the clays that fill the Gohelle-Pévèle syncline above-mentioned. The sand dips at a sharp angle below the next exposure—much broader in this case—of sandy clays, which become more sandy towards the east, and which contain scattered beds of intercalated sand. A northern sand-belt succeeds to the clay belt. Outliers of sand, belonging to this formation, make long, low ridges on the clay-belt just mentioned, such as that which bears Cassel and the Mont des Cats.

Towards the coast a deposit of marine sands, lying unconformably upon the preceding deposits, marks an intrusion of the sea in Quaternary times, while a layer of peat bears witness to a subsequent shallowing of the sea and the introduction of marsh conditions. Within historic times a further temporary invasion of the sea covered the peat with a few feet of sand and clay. The present sea-coast is defined by a smooth line of dunes formed by the sand torn from the French coasts farther west and deposited by the strong tidal currents that wash the southern shores of the North Sea. The winds have blown the sand from the strip between high and low water into long lines of dunes, which tend to work inland, and are only prevented from spreading over the cultivated land that they have been instrumental in reclaiming from the sea by the careful plantation of twitch grass and the building of tamarisk screens. *The Maritime Belt*, then, consists of a line of dunes, within which lie, first, a strip of fertile fen-land and then a strip of marine sands.

This Maritime plain does not reach as far as the ridge of Artois. A long, V-shaped gulf, once occupied the area between the ridge and Dunkirk. Down to the seventh century St. Omer was a seaport. Gravelines formed an outpost on the shores of the gulf. The reclamation of this gulf and its conversion into rich polders began in the seventh century. The little river Aa and the multitude of small drainage canals that chequer the

polder land are all that is left to remind us of this ancient intrusion of the sea, except the wave-eroded chalk cliffs of Boulonnais that overlook the marshland from the west. Faulting has in places accentuated the steepness of the angle of dip of the Boulonnais-Artois ridge. Between the Scarpe and Lawe rivers, for instance, the Vimy ridge, a continuation of the higher Notre Dame de Lorette, forms an abrupt scarped edge to the chalk plateau.

When we consider the hydrography of Flanders and have marked, what cannot fail to strike the eye immediately, the great contrast between the waterless slopes of the chalk uplands and the apparently aimless streaming of water on the clays and sands of the plain, we become aware that there is, nevertheless, a certain symmetry in the network of streams in the lowlands. The original drainage, consequent on the slope of the land, is from south to north, and certain streams of Flanders follow the trend of the ancient dip slope. Such are sections of the Deûle, the Lawe, the upper Scheldt, and the Sensée. At a later period the lowest part of the Brussels basin was displaced eastwards in the direction of Antwerp, with the result that an entirely new system of drainage developed, following the new dip-slope. The trend from west to east is much more emphatic than that of earlier times from south to north, and has had an important effect in encouraging the development of artificial waterways. The present river system draws its water from four main sources : the Aa, Lys, and Deûle from the hills of Artois ; the Scheldt from the chalk rim of Cambrésis and Hainault ; the Yser derives a copious supply from the sandy hills of the Cassel-Mont Kemmel ridge ; while the streams of the Maritime plain drain their water from the dunes that fringe the coast as well as from the low sandy hills that lie parallel to them inland.

The soils of Flanders are generally light and friable. Those covering the clay formations are more clayey in composition than those covering the sands, but nowhere are they so heavy and sticky as the soils of the London Clay. There is, as a rule, no lack of water in the soil of Flanders, although it sometimes happens that in a dry summer the peasants in the more sandy areas suffer from the withdrawal of the moisture in the subsoil which normally supplies their potatoes and vegetables. This abundance of moisture is due to the constant seeping of water from the chalk rim of upland on to the clay plain, and to the prevalence of clay on that plain ; the frequency of clay bands, which occur even in the sandy deposits, contributes also to the humidity. The constant presence of water in the subsoil, to be had by shallow boring, is a great boon to the farmer ; but the

whole of Flanders suffers, nevertheless, from the impermeability of the soil, which keeps the water on or near the surface so that it is difficult to find a constant supply which is not in danger of pollution. In spite of the fact that the rainfall is light compared with that of neighbouring areas,¹ the main physical characteristic of Flanders is its humidity. The moisture of the prevailing winds and the frequency of cloud prevent rapid evaporation from the soil. Towards the coast, but for the skill and industry of the Flemish population, water would be even excessive.

In spite of the important industrial development of Flanders and Artois, the department of Nord is still the most intensively cultivated part of France. The holdings are small and the work is, in the main, spade-work. The abundance of water ensures luxuriant growth, the light soils absorb easily the enormous amount of manure that the intensive cultivation demands. Intensive cultivation is made worth while by the proximity of a great industrial market and the excellent lines of communication by water, road and rail that the narrowing of the northern plain made necessary and that plentiful water and the level nature of the land have facilitated. Wheat and sugar-beet are the main crops of the higher ground, especially on the rim of the basin, where the *limon* is washed down from the chalk slopes. Flax still remains an important crop, especially in the northern and lower areas, as in the Scarpe valley, where the retting is easy on account of abundance of suitable water. Colza for oil is still cultivated, though the importation of cheap illuminant oils has made it much less important than of yore. Chicory-growing occupies important areas in the low coast districts north of St. Omer, where it is related to the import of coffee into the coastal ports. Bourbourg is the principal centre for its manufacture, but it is prepared in all the principal towns as well.

The plateau is economically so closely allied to the plain that we feel justified in linking the two by describing the courses of the main streams as they pass from one to the other, traversing the contrasting zones.

THE AA BASIN. The Aa rises about fifteen miles within the chalk plateau at about 600 feet, in rolling, open country where the *limon* upland provides rich ploughland for wheat and sugar-beet. It trenches a valley 300 feet deep, its lower course being gently graded. At Rumilly it reaches a line of weakness in the chalk where erosion appears to have been comparatively easy. Here it joins at right-angles a subsequent valley coming from the east, which it follows for about four miles. In this section of

¹ The mean average annual rainfall is 23 to 28 inches in the plain, as compared with 28 to 47 inches on the Artesian plateau.

its course the right side of the valley is steeper than the left, as it works down the dip slope of the chalk. At Lumbres, where a number of dry valleys converge, the Aa resumes its consequent and more rapid course, taking the direction of a tributary from the west, the Bléquin, which provides a route for the railway from St. Omer to Boulogne. The clear, rapid stream is utilized at a number of points for industry. At Lumbres, Hallines, Wizerne, and Blendecques, just above St. Omer, there are paper and cardboard mills. The industry is an ancient one, based originally on the numerous little falls of the Aa in its upper valley. Steam-power has now for the most part replaced the too feeble water-power, and the industries of the Aa have been modernized. About 3,000 people are employed in the Aa valley in the manufacture of paper and cardboard of all descriptions. The raw material, wood-pulp, is imported via Dunkirk. Local straw is used for certain papers.

The steep sides of the valley terminate to the north in a couple of bluffs which jut out like piers into the plain in long, sandy ridges, trending south-east. The river emerges from the chalk plateau at Arques, just two miles south of St. Omer, on to a mile-wide clay vale, only some thirty feet above sea-level. Beyond this vale a sandy plateau rises to about 200 feet. Winding streams or *becques*, taking their sources from water held up in the sandy soil by the underlying clay, divide this plateau into numerous flat-topped, steep-edged blocks. Just north of St. Omer the clay vale widens into a triangular basin floored with alluvium. Here the waters of the Aa now flow in a canal, and the numerous streams that emerge from the chalk or sand rims are collected into hundreds of channels bordered with trees, which divide the land into polders; but down to the end of the eighteenth century the area remained a marshland of use only to the hunter and fisherman. The basin is shut in to the north by an extension of the sand-capped Cassel ridge, the river escaping through it by the Watten Gap, a mile wide. St. Omer lies on the flat, between the chalk edge and the river and marsh at the southern outlet of the basin. The marshes form a protection to it on the north, for they can at need be converted into a broad lake when danger threatens.

St. Omer was the headquarters of the British Expeditionary Force from October 1914 to November 1915. The town formed the apex of a triangle whose base lay between Ypres and Béthune. Some eight miles behind Hazebrouck, it was in rail communication with Poperinghe, Bailleul, and Béthune—railheads for the front line—and with the ferry ports. Canals connected it with Béthune on the one hand and Calais on the other. In peace-time,

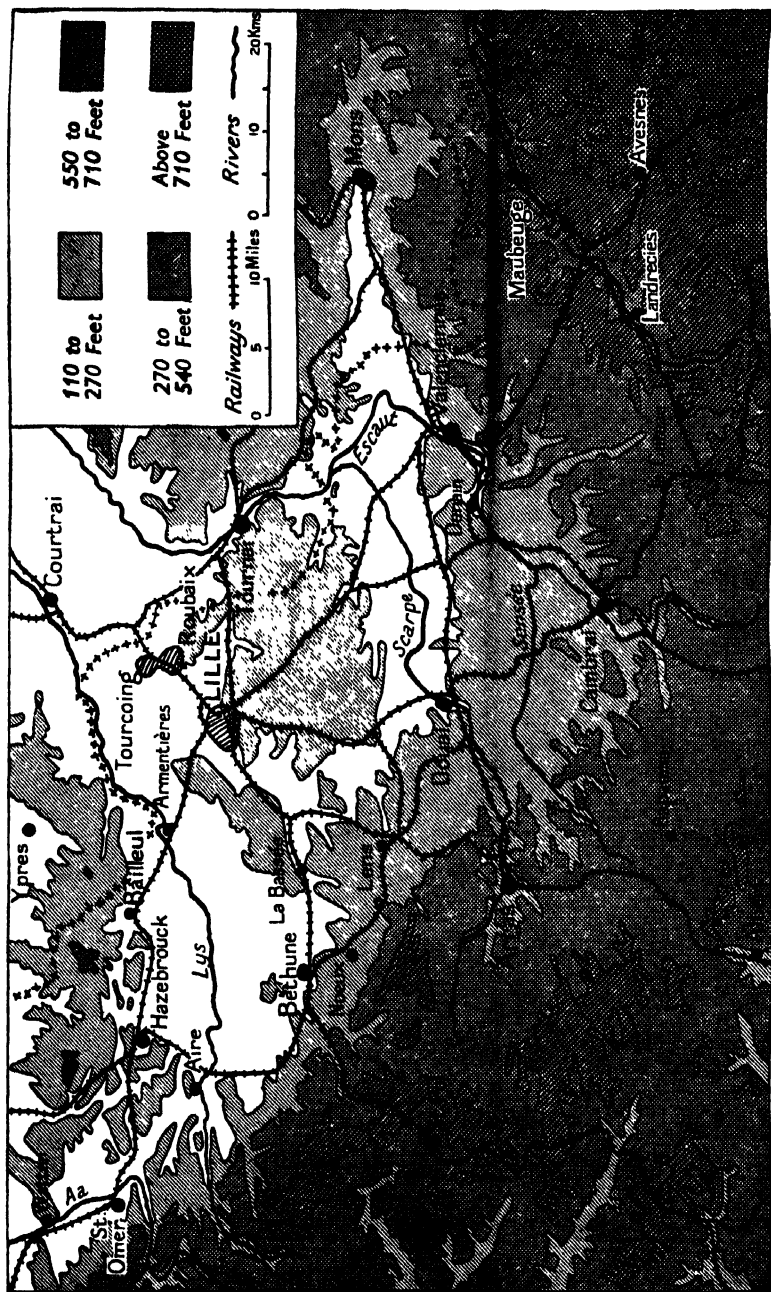


FIG. 37. THIS MAP IS DESIGNED TO BRING OUT FEATURES OF IMPORTANCE NOT GENERALLY SHOWN ON SMALL-SCALE MAPS. THE BAS-RELIEF OF THE FLANDERS PLAIN IS OF VERY GREAT IMPORTANCE, AND WAS A VITAL FACTOR IN THE WAR OF 1914-18.

no longer a port, no longer a walled city, no longer a bishopric, St. Omer is but a small market town of 17,141 inhabitants (22,000 in 1891), for the vegetable-gardens of the marshland and the ploughland of the plain and plateau. The old town lies to the west above the flood-plain. There are no roads in the marsh, the only means of reaching the *Lègres*, or market gardens, is by boat. An amphibious population of Flemings lives in scattered dwellings on the edge of the marsh or congregates in the lower suburbs of St. Omer. The waters of the St. Omer basin are now generally under control, but the draining of the marsh has increased the rapidity of the run-off, and thereby the liability of the river to flood. However, the regulation of the stream farther down has mitigated to a large extent this danger. The sole industry of St. Omer is that of *lingerie* making. There are about thirty-two factories, and a considerable export trade, though the latter has felt the high tariffs of the United States, which used to be the best market. South of St. Omer the broad clay vale, slightly raised above the marsh, is devoted to cattle pasture. Here Arques, with its jute factories and glassworks, is developing at the junction of roads and railways. It is here that a lift (Fontinette) raises the boats from the marsh level Aa canal, which connects with Calais and Dunkirk, to the level of the canals of the plain, i.e. to over sixty-five feet above sea-level. The town belongs rather to the busy valley of the upper Aa than to the agricultural plain.

The Aa leaves the St. Omer basin by the Watten Gap to continue its thirteen-mile course to the sea across the marsh, its former estuary. The slow and arduous task of draining this area is even now incomplete. At the beginning of the nineteenth century most of the area was under water every winter. Now, thanks to canalized river-beds, canals, and innumerable drains which carry off the waters that drain from the chalk in the west, and the Houtland (sandy clay and loam plateau) on the south and east, and thanks also to the sluice-gates at the gap in the dunes which allow the land waters to flow out and prevent the tidal waters from flooding in, most of the land is reclaimed, and it is only here and there, as a rule where peat cutting has lowered the natural level, that the water lies stagnant. The control of the waters of French Flanders is in the hands of ten commissions elected by the proprietors under the presidency of the sub-prefect. These commissions have complete administrative and financial control of the *Wateringues*.

Road, canal, and rail pass by the Watten Gap from the St. Omer basin into the plain of Bourbourg. The chalk hills of High Boulonnais give back to the north-west, the low clay plateau

edge curves away to the north-east, and a great marsh opens out towards the sea in a broad triangle whose base lies along the coastal dunes from Calais to the Belgian frontier, eight miles beyond Dunkirk. The Flanders Clays accompany the edge of the chalk plateau north-west, as far as Guines. At Andruic a small, isolated clay platform, rising to a hundred feet, has formed a nucleus for large-scale reclamation from the marsh by settlers from the higher land. Here sugar-beet is grown with much success for local refineries. Farther west Ardres, on the edge of the marsh, marks the junction of the two canals, Calais-St. Omer and Ardres. Ardres was a French stronghold at the time when Calais was in English hands.

After the silting up of the Aa gulf and the formation of the dunes, the river, checked in its course to the sea, began to build up a kind of a delta within the dunes, through which its waters flowed in three channels (now straightened into canals) to the sea. The present main channel to Gravelines is an artificial one, known as the Colme. A former course carried the stream out via Bourbourg, which derived some importance from the waterway. During the dry weather the dykes, or *watergands*, are kept sweet by a flow from the Aa, whose embanked bed lies above the level of the plain. The navigation canals are now, for the most part, separate from the drainage canals.

Three ports, once fortified, line the dunes to the north of the Aa marshes—Calais, Gravelines, and Dunkirk. Gravelines stands half-way between Calais and Dunkirk at the mouth of the Colme. In the seventh century it was but a collection of fishermen's huts, grouped on a number of low, artificial mounds. Commanding a navigable channel, it acquired a certain importance during the Middle Ages, was an armed citadel in the thirteenth century and became an important stronghold under the Spanish régime. Now it is only a minor fishing-port, doing a little coastal trade in salt, timber, potatoes, and fertilizers and shipping eggs to England. The shipping coming in is mainly destined for the canal system which feeds St. Omer and Béthune. The natural hinterland is the reclaimed marsh, especially the higher, better-drained polders near the coast, with their rich soils and large farms strung out along the *chaussées*. Wheat and barley are the staple crops on the deep, heavy clays, with beans and clover in rotation; but flax was for a long time the mainstay of Calais. To-day France imports 83 per cent of her flax.¹ Chicory prospers in the sandy soils near the dunes. With the introduction of sugar-beet towards the end of the nineteenth century, flax and beans gave place to

¹ France had 100,000 acres under flax in 1860; in 1920 only 25,600. See J. R. Cahill, 'D. O. T.' Report, 1928, p. 157. By 1938 there had been some revival to 69,000 acres.

the new crop, which changed the poor marshland of French Flanders into one of the most profitable areas of the plain. The raw sugar goes to the refining factories in the neighbourhood of Arras, Béthune, Boulogne, and Calais.¹

The crops of sugar-beet, chicory, and flax have turned the one-time marsh into a prosperous semi-industrial area. Sugar-refining, chicory-drying, and flax-retting occupy a considerable part of the population.

Wheat still claims a large proportion of the cultivated land, but, as elsewhere in France, and particularly since 1918, cultivation of wheat is tending to give way to pasture, more especially towards the south. Rearing of cattle and horses, fattening of cattle for the industrial markets of Lille and the neighbouring centres, and butter-making are important in French Flanders, but have not developed to the same extent as in Belgium.

Dunkirk, Calais, and Antwerp share with Gravelines the duties of catering for the immediate hinterland, but, as we shall see, their development stands on a broader base.

The large farms lying along the raised roads in the wetter areas or dotted indiscriminately among the drier polders are isolated. They are well built of brick, are whitewashed, and are arranged round a court with the inevitable midden in the centre. Villages and towns are rare; they occupy the slightly raised spots in the marsh, marking the earlier type of settlement that developed during the first stages of reclamation, or they are strung out along the waterways which serve their brickfields or chicory factories, or, like the Dutch villages, they cling to the side of a dike, the upper stories of their houses opening to the road.

Bourbourg is a small local market with about 3,000 inhabitants at the junction of the coast and St. Omer railways. It is served by the Canal de Bourbourg, by which it supplies Lille with farm produce and exports also to England via Dunkirk, the chief commodity being eggs.

Bergues, the centre of the Moères, or marshland, almost surrounded by water, with its heavy fortifications, its belfry, and great square, with the corn exchange and its Flemish houses, is, like Bruges, a relic of a decayed commercial system. Its population has dropped from 5,800 in 1891 to 3,662 in 1936.

DUNKIRK. Dunkirk and Calais have survived to play an important part in modern international trade and commerce.

¹ Most of the refineries in the invaded area were destroyed in the war. Owing to their isolated positions in open fields they frequently focused attack and counter-attack. The post-war factories, though fewer in number, tend to be larger.

Dunkirk, 'the church among the dunes', rose from the position of a little fishing-village to that of a flourishing port as the ports of St. Omer and Bruges decayed. Natural advantages it had few, apart from a safe approach in the stormy entrance to the channel provided by the banks which form a breakwater parallel with the shore. There are, however, on these shallow coasts strong currents which hinder navigation. Built upon the dunes, which rise around and within the fortifications, Dunkirk owes its development as a modern port in the nineteenth century entirely to artificial means. The rich agriculture and the industry of western Flanders had to find an outlet when the ports of the Aa estuary became silted. The canals of Bergues and Bourbourg put the port into communication with the hinterland, the railways made it worth while to construct a modern harbour. From 1875 to the outbreak of war in 1914 the accommodation of the port had increased rapidly, and it was hoped that, as an outlet for the whole of eastern France, Dunkirk would justify the expenditure that has been devoted to bringing its equipment up to date. In 1936 it had a population of 28,450. During the wars, it was heavily bombarded from land, sea, and air by the Germans and some 1,600 casualties resulted. Material damage was slight, however, and the place derived certain advantages when it became an English naval base for coastal operations, and some progress was made in the enlargement of the port. Notably the fifth dock basin was completed in 1917. Among other things, cold storage accommodation was installed for meat for the troops. This has remained a permanent asset. The British established a ferry-boat landing here for the Richborough train ferry which has since been transferred to a Harwich-Zeebrugge crossing. To-day the entrance channel has a low-water depth of twelve feet and a high-water depth of thirty-three feet. The new Freycinet dock basins have an average low-water depth of twenty-five feet. This is a great advance on pre-1914 conditions, but, considering the importance of the textile, mining, metallurgical, and agricultural regions that lie behind the port, the accommodation is still inadequate. The greatest asset of Dunkirk to-day is the girdle of railway sidings that serve the port and link it to the system of the Nord. The London, Midland and Scottish Railway arranges a regular passenger service to Dunkirk. The import of coal, timber, grain, ores, wool, and fertilizer, and the export of sugar, were the main activities of the port before 1914—activities obviously closely connected with the *grand agriculture* of Flanders, Artois, and Picardy, and with the industries of the coal-fields of Nord and Pas de Calais. The accompanying map shows the water connexions of Dunkirk and

the possible extension of its hinterland into the Paris basin by the Canal du Nord and into Lorraine by the Canal de l'Est.¹ Coal, oil-cake, and Chile nitrates still form the bulk of incoming cargoes; grain, pit-props, iron ore, mineral oil, hemp and jute, phosphates, and oil-seeds are also important. Dunkirk is the chief French port for wool, as Le Havre is for cotton. It is also an important entrepôt port for sugar. Flax is imported from the United States. Exports are mainly sugar to England,

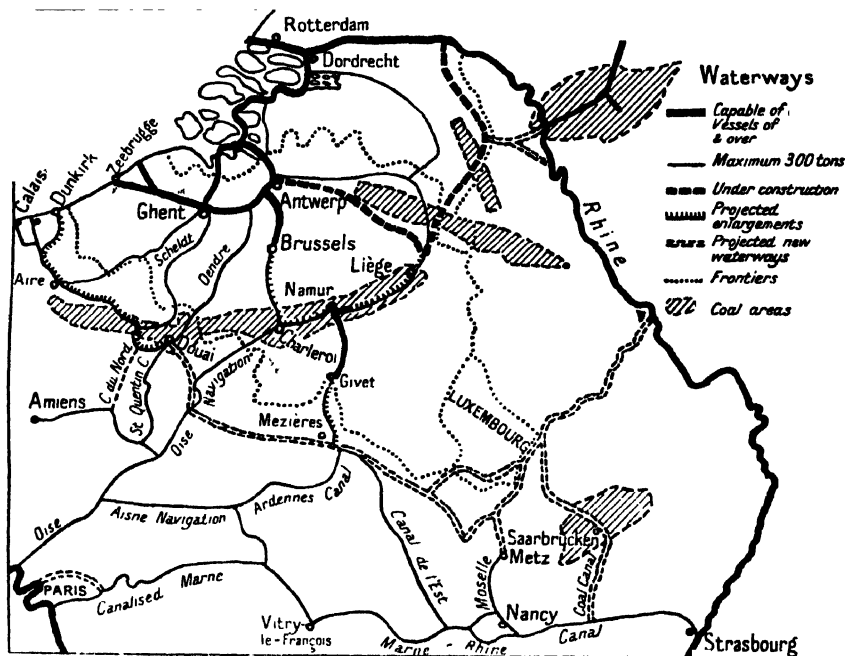


FIG. 38. SHOWS THE BELGIAN WATERWAYS AND THEIR TRANSFRONTIER COMMUNICATIONS IN RELATION TO THE PORTS AND THE COAL-FIELDS. IMPROVEMENT SCHEMES ARE INDICATED²

machinery and hardware to the Far East and to Africa, and paper and textiles to the French colonies. Local industries are few, chicory-grinding is perhaps the most important, but there are others fed by the port, such as saw-mills, mineral oil refineries, oil-seed mills, hemp and jute and textile factories. Dunkirk receives coastwise from the French Channel and Atlantic ports goods in large quantities: food-stuffs, constructional material, cotton, salt, pit-props, and oil—and sends out coal to Atlantic and Mediterranean ports, fertilizers to Brittany, etc.

¹ Only about one-sixth of the interior traffic of Dunkirk goes by water.

² The Juliana C. was completed in 1936, the Albert C. in 1939 (opened 1940).

Most of this multifarious traffic is entrepôt trade, for Dunkirk has no special market except for timber. The town remains small and cramped between the fortifications and the docks, but, to the north, the suburban watering-place of Malo-les-Bains is developing. To the south the small industrial suburb of St. Pol-sur-Mer is growing more slowly on the site of the British war-time aerodrome.

CALAIS. Calais is a dune town like Dunkirk and Gravelines. Its growth as a port is definitely related to the shortness of the Channel crossing to Dover: eighteen miles as the crow flies. It is the natural outlet of the St. Omer hinterland, but is less closely related than Dunkirk to the industrial areas of the coal-field and the Lille complex.

The old town and the citadel stand on a dune island completely surrounded by the basins and canals of the port. The high church tower appears to emerge from the sea as one approaches Calais from the Channel and forms a useful landmark. Behind the dunes and built on the reclaimed marsh is a large modern industrial town which has grown up as a result of favourable canal and rail communications, themselves dependent on cross-Channel traffic and the main line to Paris. The natural approach is not very favourable to shipping, although there is no bar at the entrance to the harbour. During the War port-equipment was greatly improved to meet military requirements, new quays and a new deep water dock (twenty-six to thirty feet) being completed.

The main traffic is passenger traffic, between three and four hundred thousand passengers passing through the port per annum. The goods traffic, as at Boulogne, is a small package traffic for the most part, but, though the bulk and weight do not reach high figures, the value of the goods is very considerable. Food-stuffs, such as poultry, wine, and dairy produce, yarns, lace and tulle are exported. There is also coastwise traffic in grain, sugar, fertilizer, and building stone.

Industrial Calais, or the town of St. Pierre, is chiefly engaged in machine lace-making,¹ for which it is the chief centre in France. Tulle, which is the foundation of much machine-made lace, is also manufactured, though Caudry, near Le Câteau, in the department of Nord, has a greater output. The industry is in close relation to the *lingerie* industry of the St. Omer district, and Calais also has factories for making Swiss and other types of embroidery. A later development was the establishment of an important English artificial silk works. The export of lace

¹ The number of persons employed in the lace and embroidery industry of the department of Pas de Calais (Census 1926) was 13,158.

is the mainstay of industrial Calais, which is highly sensitive to the demands of the United States market.

THE LYS BASIN. The river Lys is the main drainage artery of French Flanders (Fig. 34). It rises in the latitude of Bruay and follows for five miles a line of soft rock parallel with the chalk escarpment. It continues north through the bald plateau of chalk, then bends round to flow north-east parallel with the Aa to Théroouanne. It passes Fruges, a railway junction on the Arras-Calais line, which has a boot factory and a horse fair, both concerned with local products. The river turns mills all along its course, for it rapidly becomes a powerful stream. Roads radiate from Théroouanne across the plateau and along the valley edges in all directions. Here the Chaussé Brunehaut, following the middle terrace of the chalk escarpment in the direction of Arras, crosses the river.¹ The town is probably the site of the Romano-Gallic station of Teruanna. Through it the Roman road passed from Arras to the coast. The nodality of its position, no doubt, led to its being besieged in 1513 by Henry VIII in the Battle of the Spurs. At a later date it became a bishopric of some importance. The old Théroouanne was completely destroyed by Charles Quint; the modern town lies at the foot of the bluff that bore the old fortified city. A single-track railway follows the Lys valley, which, like that of the Aa, is crowded with life. Coal is mined along the Théroouanne-Arras road.

On the cultivated platform, 100 to 150 feet high, which follows the foot of the chalk scarp, the villages are numerous, especially on the edges of the valleys where the water puts out. Aire-sur-la-Lys marks the descent of the stream into the *pays-bas* at sixty-six feet above sea-level. Aire is a little circular town, at one time walled, built on the same plan as so many of the ancient Flemish strongholds, e.g. St. Pol and St. Venant. These little fortress towns are hemmed in by their walls, cannot readily expand, and adapt themselves with difficulty to modern conditions. Again and again we see them decrease in importance in favour of some modern industrial rival. Yet Aire has a convenient situation from the point of view of land and water communication and was for a time the headquarters of the first British Army. Here the Lys is joined by the Laquette, in whose upper valley lie the coal-mining villages of Enquin and Fléchinelle, connected with the Aire canal by a light railway, for near this point begin the coal-fields that stretch through the departments of Pas de Calais and Nord to continue through Belgium and Holland to Germany and the Rhine. From here the Lys is

¹ There is a drop of about 300 feet between the plateau-top and the terrace, and a further drop of about 300 feet to the platform at the base of the escarpment.

canalized and joins the Neufossé, which connects with Calais and the La Bassée canal. The little town of Aire may congratulate itself on having resisted inclusion into the ugly squalor of the coal-field.

A couple of miles below Aire, near Isbergues, which is a port, railway junction, and steel manufacturing centre¹ on the La Bassée canal, the river debouches from the chalk platform on to the broad flats of the Lys basin (Fig. 37). Here the Ypres clay is covered with some five feet of loam or sandy clay. There is little to distinguish the Lys plain from the maritime plain, except perhaps the height above sea-level. The maritime plain lies, for the most part, below the thirty-feet contour line, the Lys plain between fifty and a hundred feet. The upper Lys basin is bounded to the south-west by the escarpment of the Artois ridge and to the south-east by the Aubers ridge, which projects north-east from the widening platform of the Pévèle. The Cassel-Kemmel ridge forms the northern side of the triangle. Three outlets from the basin are marked by the towns of Aire-sur-Lys, Warneton, and La Bassée. Water streams into it from the chalk in the south and from the low, sand-capped clay plateau that separates it from the Aa and Yser basins in the north. This clay plateau, where the sand-capping does not hide it, is covered with a rich red-brown loam. The land is divided into large fields, all under the plough.

In spite of the *watergands* that intersect the plain to carry off the water, floods are not infrequent along the Lys. When the river rises in winter its waters pond back its tributaries for several miles. Much has been done in the last century to relieve the waterlogged condition of the land, which gives rise to marsh fever among other grave disadvantages, and broad ditches have given place to drains, with the result that much land has been reclaimed for agriculture. Wheat, sugar-beet, and potatoes are the main crops, as in the reclaimed Aa delta; the latter crop, flourishing on the light soils, bids fair to outstrip the others. Spade cultivation is the rule here, and the holdings are small. Labour is very cheap when we consider that often the farmers and their whole families toil for some twelve to eighteen hours a day on the farm. Cattle-rearing, as in the north and east, is becoming more and more important. The wet pastures are no longer the main support of the animals—oil-cake, forage plants, especially clover, and sugar-beet refuse feed them for half the year. Every farm of seventy to a hundred acres has its fifteen to twenty cows.²

¹ These are the only important steel works of Pas de Calais.

² Raoul Blanchard : *La Flandre*, Paris, 1906.

The Lys basin has developed a textile industry which is subsidiary to Lille. Small factories engaged in spinning and weaving cotton, linen, jute, and hemp, are dotted along the waterways from Isbergues to Armentières. Armentières itself has linen factories. Bailleul and Hazebrouck, on the edge of the Cassel ridge, have linen and lace-making industries. But away from canal and main railway the basin is purely agricultural. St. Venant, like Aire, has remained a tiny market town with about 1,100 inhabitants.

Small market towns lie round the edge of the basin in the south, in similar positions to that of Aire, above the marsh and at points where valleys descending from the chalk downs converge, e.g. Lillers at ninety-five feet above sea-level on a tributary of the Clarence, Béthune at seventy-nine feet on the Lawe and La Bassée canal. From Béthune three roads pass south into the coal basin of Gohelle, and others lead up the valleys to St. Pol and Arras. The development of the coal-field led to the transformation of Béthune. It was originally fortified like Aire and St. Omer, with a small population of about 7,000 inhabitants, including a garrison. Now it is an industrial town of some importance with a population of 19,370. A double-track railway line, diverging from the line that follows the edge of the basin, links Béthune with Aire and Arras. If we follow the circular line eastwards we reach La Bassée at the terminus of the canal and on the edge of the upland commanding the road south to the coal-field and Lens and north to the centre of the basin at Estaire on the Lys. It lies in a gap between the foot of a spur of chalk upland and the end of a long ridge of Tertiary loam-covered clay which extends to the Deûle north of Lille, forming the famous Aubers ridge. Railway and canal pass through this gap to Lille. It was a strategic point of the greatest importance during the war of 1914-18, controlling the lines of communication east to the Lille industrial region and south to the coal-field.

THE PLATEAU OF YPRES. North of the basin of the Lys and dividing it from the maritime plain, is the low, dissected Ypresian plateau,¹ which stretches for about fifteen miles northward between the Lys and the polder land north of Bergues. A broken ridge of sand lying upon the Ypres clay explains the steep-sided hill upon which stands Cassel at 515 feet and the Mont des Cats at 518 feet, with its Trappist monastery, eight miles to the east of Cassel. Cassel was a Roman strong point, and was a fortress throughout the Middle Ages. Owing to the

¹ See p. 175.

generally low level of the surrounding country the view from Mont Cassel is very extensive. It was the base for General Foch's attack in the autumn of 1914, and formed the headquarters of Plumer's army in 1916-18. Eastward of Cassel the plateau narrows to a ridge, still capped with sand, which rises to form commanding summits in Mont Rouge, Mont Kemmel, and Wytschaete, and then sweeps north-east round the basin of Ypres. Hazebrouck and Bailleul lie upon its southern edge. The former was a vital railway junction for the British Army in the War. It is connected with the Lys by the canalized Bourre.¹ The great contrast between the *pays-bas* of the Lys basin and the *houtland* of the Ypresian plateau was brought out strikingly by the events of the War. Before the battle of the Lys in 1918 the German line along the northern edge of the Aubers ridge passed east of Armentières across the Lys, and so northwards along a line that skirted the Ypres ridge, just above the marsh. From the vantage-ground of the Aubers ridge the Germans could survey the activities of the Allies in the waterlogged plain, with its ever-impeding water channels. At a terrific price, the British held the Messines ridge, running south from Wytschaete—the key to the Ypres salient. In April 1918 the Germans made their great thrust against the Armentières-Festubert line, which they broke at Neuvechappelle, about four miles north of the La Bassée canal. In the subsequent fighting the British retreat, pivoting on Wytschaete on the one hand and Festubert, four miles east of Béthune, on the other, laid open the Lys basin, into which the Germans advanced to its western extremity, west of St. Venant. Backed by the forest of Nieppe, the British forces were able to stem the German advance on the vital railway junction of Hazebrouck. The situation was now reversed. The Germans occupied the marshy lowland and the Allies the surrounding heights, which, from the first, had been strenuously defended. The final and most desperate efforts of the enemy to gain control of the northern heights resulted in the re-taking of the Messines ridge and Kemmel, but the Mont des Cats and Cassel remained in British hands.

South of the French Lys basin the platform of Gohelle juts out from the foot of the chalk escarpment. It stands at from 100 to 200 feet above sea-level, sloping gently towards the Lys. Its breadth varies from two to six miles. Strung out along it in a west-north-west direction, and stretching up into the valleys that penetrate the escarpment, lie the colliery towns and villages almost touching one another for about forty miles. Enquin-les-Mines, six miles south-west of Aire-sur-la-Lys lies

¹ See Fig. 37.

at one extremity, and Anzin, two miles west of Valenciennes at the other. Between the coal-fields and the chalk escarpment the Gohelle district offers a strip of fertile chalk marl country, with the scattered farming villages of Bailleul, Givenchy, Arleux, Fresnoy, and Oppy—most of them shelled to pieces during the battles for the Vimy ridge in 1917 and 1918. The famous ridge is a striking feature seen from the plain of Gohelle. It rises abruptly in an escarpment facing the Flanders plain, and is little less dominant from the south-west, where it overlooks Arras. It is an extension of the still higher ridge of Notre Dame de Lorette, from which it is divided by the valley of the Souchez.

Lillers and Béthune, on which the coal-valley railways converge, are the controlling centres of the mining valleys. Lillers, at the foot of the escarpment, boasts the oldest artesian well in Europe. All the eastern part of the coal-field drains to the Lys by a number of short streams that notch the escarpment and cross Gohelle from south-west to north-east. The Lens district is drained by the Souchez-Deûle which passes south of the Aubers ridge to Lille.

Lille lies cramped within its fortifications, which form a great triangle pointing north. It lies on the Deûle at the junction of the canal. Outside the ramparts and separated from the town by a military zone lies a girdle of industrial suburbs, once separate villages. The total population in 1936 was 193,158. Five miles or so to the north-east lie the twin towns of Tourcoing-Roubaix, just within the French frontier. To the north and north-west, along the edge of the Messines-Kemmel ridge are the frontier villages of Hallouin, Courmes, and Deûlemont and the manufacturing towns of Quesnoy and Armentières. Lille is in contact with Belgium by rail and canal and much traffic crosses the frontier.

Fig. 37 shows the area of devastation of the war of 1914-18. The collieries were worked close up to the fighting line in both ally and enemy lines. The waste dumps from the mines, rising to a hundred feet above the plain, formed valuable observation-posts from which the movements of troops could be observed, and their possession was sharply contested. The end of the war saw most of southern French Flanders a wilderness of torn and scarred earth, shattered and splintered tree-stumps, shell-holes filled with stagnant water, miles of tangled and rusting barbed wire and scattered remnants of villages and farm buildings, which were often reduced to heaps of brick-dust and lime.

The coal towns and villages were rebuilt and the mines are busier than ever. The hideous lines of *corons*, or miners' huts, have been replaced by more substantial and sanitary brick houses, with gardens enclosed in cement fences. Ferro-concrete

played a very large part in the reconstruction of these places, as exemplified in the new railway station at Lens, but brick still plays the major role in the construction of the long streets of artisans' houses and shops. The material for building construction was fortunately at hand in the many brick-fields that are dotted over the Flanders plain and in the cement works of Pas de Calais. This region was the most densely peopled region of France, apart from the Paris area, having a pre-1914 density of 1·4 inhabitants to the acre. The population has dropped considerably as a result of the war of 1914-18. Certain villages in the poorer agricultural districts were too completely wiped out to be reconstructed. Their ruins are now ploughed into the ground and their sites are marked to-day by the simple but tragic statement 'Here stood . . . destroyed . . .'

The Scarpe, the Sensée, and the Escaut (Scheldt) drain the south-eastern part of the Sill of Artois, which terminates in Cambrésis. Here the chalk of the plateau is covered with a thick layer of fertile loam.

Arras lies on the right bank of the Scarpe, just behind and to the south-west of the Vimy Ridge, at a point where three valleys from the plateau converge on the edge of the Flanders plain. It is the market town of the densely-populated agricultural high plain of Artois, and the link between the wheat and sugar-beet lands of the upland and the more diverse cultivation of the plain ; but it has a nodality that is much wider than these local conditions are able to account for. On it converge railways from Paris to Amiens, Boulogne, Calais, Dunkirk, Ghent, and Brussels, for it commands three important natural routes across the Sill of Artois, which is the main gateway to north central Europe.

The old Flemish city early became famous for its woollen industry, and particularly for tapestries (Arras hangings), which it no longer manufactures. Its nodality has enabled it to develop other industries. It has oil-seed crushing mills and makes soap and candles. This industry was based originally on the cultivation of colza and flax in the surrounding district. It makes agricultural machinery and equipment for the sugar refineries, distilleries, etc., of the region, and in recent years has developed the fabrication of electrical apparatus. For four years the centre of the town was battered by enemy shells, and in some quarters little was left but the labyrinths of cellars. The soft chalk beneath the city is honeycombed with cellars and quarry workings and great sewers. These were expanded and utilized to shelter the troops before the battle of Arras, and great tunnels were driven out to quarry workings without the town in 'no man's land'.

THE SCHELDT BASIN. The marshy Scarpe valley, passing south of the Vimy ridge, cuts a passage across the lower chalk terrace, and so to the edge of the plain and the coal-field at Douai ten miles from Arras. The valley sides here are lined with metallurgical factories, and one industrial village merges into the next. After traversing the coal-field it debouches on to a broad alluvial-filled trench which stretches between Douai and St. Amand and lies along the northern edge of the mining zone. It receives a large number of streams from Pévèle, which in this longitude extends north to Lille. The whole country is intersected with streams and ditches. Towards the east the alluvial floor of the trench is sandy and bears the Forest of Raismes.

Douai, also an old Flemish town, retains a few of its ancient houses, but is to-day a busy manufacturing town of 38,379 inhabitants. Surrounded by mines and dumps of coal waste, it is the most important of the coal-exporting centres of the region. The Scarpe derivation canal forms a valuable port, and the canalized Scarpe bears a heavy traffic (Fig. 94).

St. Amand is a little town built round a former Benedictine abbey in the Scarpe marshes, which are intersected by a network of canalized streams. Its pottery industry is supplied by local clays, and it possesses a spa based on hot sulphur springs from the edge of the sandy zone. Three miles north of St. Amand the Scarpe turns north to join the Escaut on the Belgian frontier, where it cuts through an exposure of chalk on the edge of the Pévèle platform.

The Sensée, Agache, and Escaut drain the northern brink of the chalk plateau in deeply-incised valleys, and enter the longitudinal vale of the Sensée-Escaut, which lies parallel with that of the Scarpe but to the south of the coal-field. The Sensée valley is trenched into the chalk, and resembles the valley of the Somme, with flat flood-plain covered with meres, rather than the rivers of Flanders.

Cambrai lies above and to the south of the Sensée vale at an elevation of 250 feet. It is the centre of the agricultural district of Cambrésis, and it is also the centre of a textile industry of some importance. The district specializes in the manufacture of fine linen goods, known in this country as cambrics; tulle and lace are also made. There are, in addition, a number of wool-weaving mills, hosiery, and machine-made embroidery works. Thus the textile industry extends to both sides of the Sill of Artois.

The north-east to south-west ridges of the downs between the

dry valleys formed important lines of defence and were strengthened between the Escaut and Agache valleys by the Germans to form the famous Hindenburg (or Siegfried) line. The Escaut traverses the coal-field between Bouchain and Condé, beyond which it turns north-east in the direction of Tournai, while the coal-belt extends east-north-east across the frontier in the direction of Mons. The old city of *Valenciennes* and its modern industrial annexe lie on either side of the Escaut canal. The ancient hand-made lace industry, for which the town was famous from the sixteenth century to the end of the eighteenth century, has died out, but a very important tulle and machine-lace industry has developed at Caudry, south-east of Cambrai, at which Valenciennes and other lace is imitated. Valenciennes, in the meantime, owing to its position on the coal-field and its proximity to sources of Belgian coking coal, has developed very important metallurgical works of all types, both heavy and light engineering, boiler-making, agricultural machinery-making, electrical motors, and so forth.

The Sambre has but a short course in France. It rises in the northern edge of the Forêt du Nouvion and skirts the western extremity of the agricultural and dairy-land plateau of Thiérache, where the chalk rises on the flanks of the Ardennes Massif. At Landrecies it enters the great Sambre-Meuse furrow, which continues north-east in a direct line to Charleroi. It has only a slight gradient, and the valley is only about sixty feet deep. Parallel with this important modern route-way, and on the other side of the great Mormal forest, runs, straight as if ruled, the ancient road from Paris via Le Câteau to Bavai, and thence via Binche to Aix-la-Chapelle and the Rhine at Cologne. To-day the canalized Sambre, linked with the Oise by canal at Landrecies, supplies the Paris basin with Belgian coal and coke (Fig. 96).

The fertile region of *Thiérache*, with its dairy centres of Sains-du-Nord, Sobre-le-Château, supplies the industrial north and Paris with milk.¹

Between Berlaimont and Maubeuge the Sambre valley is entirely industrial, and the industrial villages cling also round the north and north-eastern edge of the Forest of Mormal between Bavai and Maubeuge, the main industry being metallurgical, the successor of an ancient iron industry based on local ores from the sands of the Massif, charcoal from the surrounding forests, and power from the Sambre tributaries. There is a great variety of manufacture—boiler- and vat-making at Saint Waast and Rousies, bolt-making at Bavai and Hautmont, metal-stamping and cutting at Maubeuge, Rousies and Requinies, iron and steel

¹ See p. 408.

tubes at Louvroil, Haumont, Requinies, and Aulnoye, machine tools at Maubeuge and Aulnoye.

We see then that on either side of the coal-belt there are extensions of the industrial area which are based on important lines of communication: the textile areas of the Lille-Roubaix-Tourcoing group to the north and the Cambrai-Caudry-Le Câteau group to the south, and in the south-east the Berlaimont-Maubeuge metallurgical group.

THE COAL-BASIN. The coal-field of the Nord and Pas de Calais is the western extremity of a long line of coal deposits that stretches from the Rhine via Aix-la-Chapelle (Aachen), Maestricht,

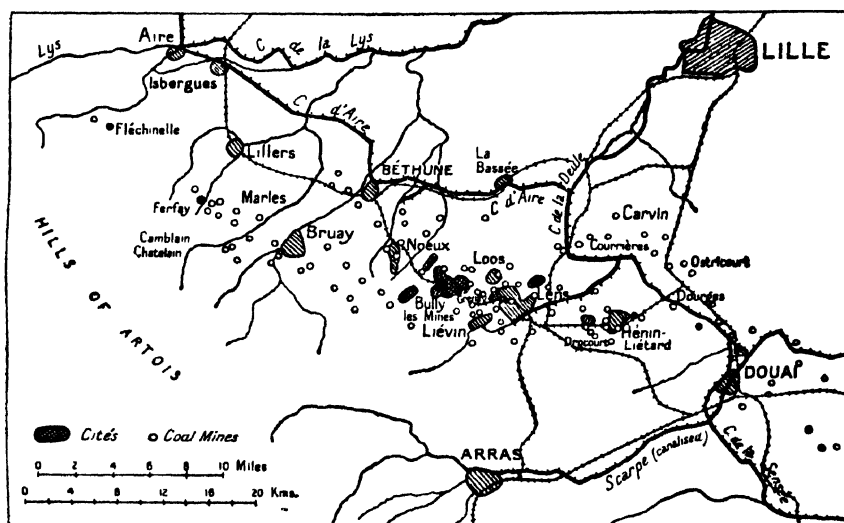


FIG. 39. SHOWS THE CANALS THAT SERVE THE WESTERN COAL-FIELD

Liège, and Namur and crosses the Franco-Belgian frontier between the villages of Quiévrechain and Péruwelz. As in the other coal-fields of France, the coal has been preserved in a furrow of the Hercynian mountain system along with older and younger sedimentary rocks. Later earth movements, which raised the Massif of the Ardennes, caused great lines of faulting along its northern edges, and over-thrusting in a northern direction took place, so that, in the southern edge of the basin, sedimentary rocks older than the Carboniferous lie above the coal measures, which have been folded over on themselves. The fracturing of the earth's crust along the northern edge of the Ardennes Massif has greatly disturbed the coal measures, so that they do not lie in continuous beds but are much interrupted and displaced, and in consequence

difficult and costly to work. A minor furrow to the south of the main deposits has preserved coal in a few isolated patches in the basin of Dinant.

In France the coal-field runs in a narrow belt, covering an area of about 127,000 acres, across the departments of Nord and Pas de Calais for sixty miles, terminating in a point at Fléchinelle in the basin of the Lys. It narrows to about three miles at Flers to the west of Douai, and widens to eight miles at Lens. It runs from north-east to south-west from the frontier through Valenciennes to Quiche, and then, near Douai, turns north-west. In Pas de Calais it assumes an almost east to west direction. Coal occurs in unworkable conditions in Boulonnais, marking the continuation of the deposits in the Hercynian furrow in the direction of the Kent coal-field.

In addition to the difficulties caused by the general faulting and dislocation of the coal measures, along the Eifel fault there are many local fractures and disturbances of the seams. The seams are numerous, generally only three to six feet thick,¹ and are mined to a depth of 3,000 feet, the average being about 1,300 feet. In the neighbourhood of Aubry a promontory of ancient sedimentary rocks has been thrust northward, dividing the workable coal measures into two basins—the Valenciennes basin in the east and the Lens or Pas de Calais basin in the west.

The composition and the quality of the coal varies greatly, calorific value lying between 8,200 and 8,500. In the high seams gas coal predominates. At Aniche, coal with a 32 per cent volatile content is mined, as well as hard anthracite coal. In the Anzin mines, which include concessions at Anzin, Raismes, Denain, Vieux Condé, and Fresnes, and in the Bully-Grenay and Courrières concessions all kinds of coal are mined except anthracite. In the Vicoigne-Noeux-Drocourt concessions anthracite is mined as well. In the Lens-Liévin district, at Marles and Drocourt, the coals have a high percentage of volatile matter, while the Ostricourt, Vendin-les-Béthune, Thivencelles-St. Aybert mines produce only hard coals and anthracite.

Most of the mines have coking-ovens attached, and the by-products—coal-tar, ammonia, etc.—form the raw material for a number of chemical industries. The coking-ovens are more numerous in the western section of the field than in the east.

The coal forms an important article of commerce both within the coal-field itself and outside the basin. Much coal is sent by rail and canal into the interior of France, chiefly in the direction of Paris, and some passes across the Belgian frontier in exchange

¹ The average worked coal seam is about 3 feet thick.

for coke or coking coal. Lens and Douai are the main exporting centres (Fig. 96).

The number of persons employed in the coal mines of the departments of Nord and Pas de Calais in 1936 was 136,069. Of these nearly 70,000 were foreigners, mainly Poles and Belgians.

Apart from the coking and chemical industries in which coal and coal products are the raw material, coal fuel is the basis of very important metallurgical works situated upon the coal-field.

THE METALLURGICAL INDUSTRY. No iron-ore is produced on the coal-field and not a great quantity of pig-iron is made. Ore is imported from Lorraine, Luxemburg, Sweden, and Spain. On the other hand, the Nord department produces large quantities of partly worked steel and increasing quantities of scrap and waste iron (residue from pyrites-roasting process in local chemical works) are used. Isbergues in Pas de Calais smelts haematite ores. For the rest, iron and steel works produce great quantities of iron and steel in blooms and billets and a great variety of finished and semi-finished articles, parts of railway rolling stock, steel rails, steel plates, and forged steel, from small portions of machinery to parts weighing many tons. The chief centres for heavy metallurgy are at Douai and in the Anzin-Trith-Denain district along the Scheldt canal, and at Louvroil and Haumont on the canalized Sambre. The principal centres for manufactured iron and steel are Isbergues near Aire, Leffrinkhoucke near Dunkirk, Lesquin, Anor in Thiérache, Jeumont, Aulnoye, Sous-le-Bois and St. Amand. Douai is the largest town in the iron and steel industry. Metal working is carried on in all the larger centres of the two departments, both on and off the coal-field. There is an increasing amount of machine construction of all kinds, particularly of textile machinery. Lille and Roubaix are important centres for textile machinery, as one would expect; but Cambrai and Arras, Maubeuge and Aulnoye make machines and tools. There is much specialization also—Cambrai makes dairy utensils, St. Amand and Anzin chains and anchors, Trith and St. Léger specialize in wire-drawing. Electrical apparatus is manufactured in a large number of places. Lille, and especially its eastern suburb Fives, have a number of important engineering works and turn out agricultural machinery, electric motors, railway rolling stock, and have stamping mills and boiler-works.

THE TEXTILE INDUSTRY. Except in the Valenciennes area the textile industry does not lie upon the coal-field. The main group of textile manufactures lies in the enclave that France forms in the Belgian frontier between Armentières and Bachy. Lille lies in the centre and forms the industrial nucleus of this region.

The earliest industries of wool and flax were represented here

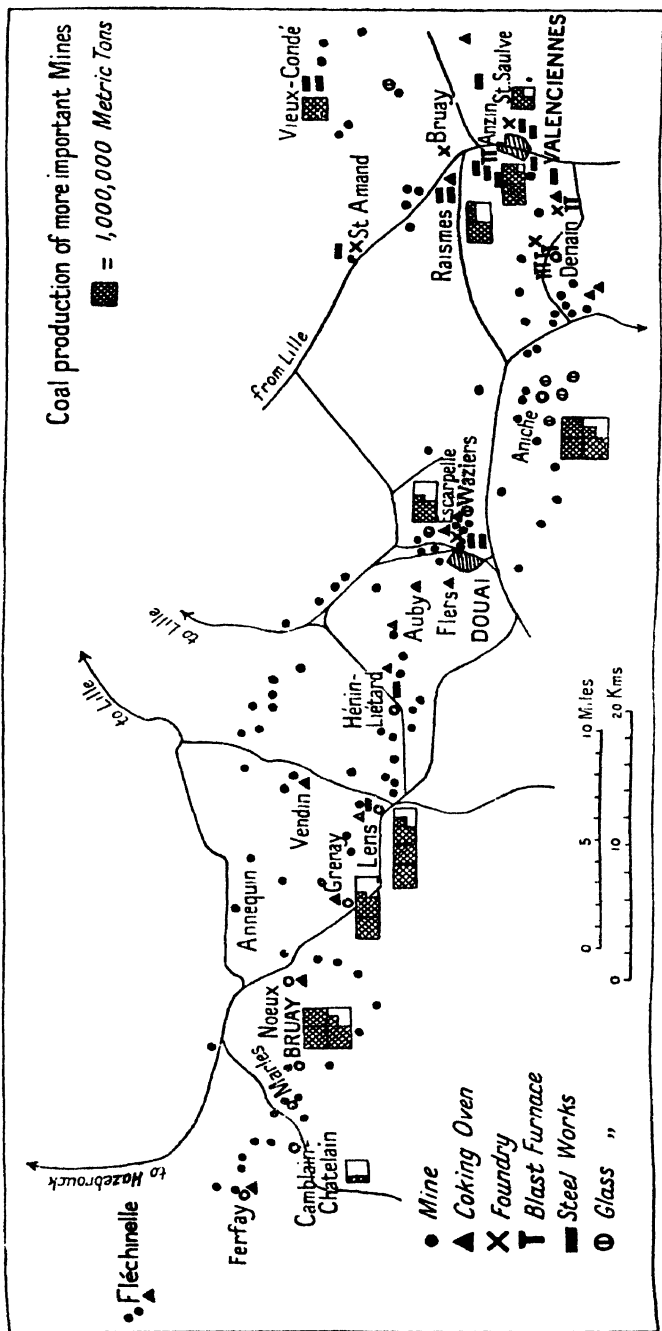


FIG. 40. SHOWS THE INDUSTRIAL REGION OF NORD AND PAS DE CALAIS BASED ON THE FLANDERS COAL-FIELD. LENS AND DOUAI ARE THE MAIN COAL DISTRIBUTING CENTRES.

as well as in the valleys of Artois. Local wool was used first and then wool relayed from the London market, down to the middle of the nineteenth century, when merchants of Tourcoing began to seek wool in La Plata and later in Australia. Woolcombing has always been a special industry of the Roubaix-Tourcoing district. To-day the annual production of woollen yarn is in the neighbourhood of 65,000,000 pounds and occupies thirteen to fifteen thousand hands. There is an immense variety of woollen goods produced and the quality is usually high. About 15,000,000 pounds of carded wool are also made here, employing about 12,500 workers. Wool-weaving is also carried on in the Cambrai district and again at Fourmies in Thiérache.

There are some fourteen towns interested in cotton-spinning. They fall chiefly into the Armentières-Lille-Roubaix-Tourcoing groups, but Dunkirk and Hazebrouck also have mills, and Auchy-les-Hesdin in Pas de Calais. In the Lille district the finer counts are spun, Egyptian cotton being used. There are about 2,000,000 spindles and 13,000 hands employed. The Roubaix-Tourcoing group has about 1,000,000 spindles and employs 11,000 hands. Lille, Hallouin, and La Bassée are the chief spinning centres, where all kinds of fabrics are made of cotton, linen, jute, wool, and silk.

The situation of the textile area is a happy one, in the main transcontinental thoroughfare between the Kemmel ridge and the edge of the Ardennes upland, close to the French and Belgian mines, with a convenient outlet via Ghent or Dunkirk and with a large and varied local market to cater for.

The 'gainfully employed' population of the department of Nord was 942,759 in 1926, of whom 284,900 were women. About one-eighth of these were foreigners, mainly Belgians. In textile industries 199,298 people were employed, of whom about 97,900 were women.¹

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¹ The relative importance of the woollen industry in the department is shown by the following figures of persons employed. In round numbers :

Wool	80,000
Linen, Hemp and Jute	54,000
Cotton	28,000

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CHAPTER VI

THE PYRENEES

LES Pyrénées ont perdu leur vie propre pour n'être plus qu'une frontière,' says M. Sorre.¹ If that be so, one is tempted to remark that they are but reverting to the function for which Nature has best fitted them—at all events so far as the French side is concerned. The things that most forcibly strike the student of the geography of the Pyrenees are the steepness of the front that the mountains present to the plains of the Garonne and the Aude, the continuity of the barrier offered by the central zone, and the narrowness of that barrier in relation to its length. For 260 miles the Pyrenees stretch from Cape Creuse on the Mediterranean to Cape Higeur on the Bay of Biscay; but their greatest width is only about 60 miles and, it decreases to less than 20 miles in Navarre. Compare the 130 miles that separate Saluzzon and Lorient, or Turin and Romans in the 180 miles of length in which the Alps form the French frontier. Within a few miles of the Mediterranean the Canigou rises to 9,000 feet, and the barrier never drops to below 5,000 feet till we reach the Saison valley to the west of the Pic d'Anie, a distance of about 300 miles. In the central Pyrenees the level only once drops below 6,500 feet. True, the Pyrenean barrier becomes much less formidable at the eastern and western extremities. In the east it narrows to about 6 miles in the Monts d'Albères, between the plains of Roussillon and Ampurdan. From the west coast, for some 30 miles as the crow flies, the barrier is below 3,000 feet.

The characteristics just mentioned, however, are not the only ones that limit the function of the Pyrenees from the point of view of human occupation. Another striking feature of the range is the almost total lack of longitudinal valleys within the uplands.² The rivers on the French side all flow transversely, parallel to one another, and there is no union of the large tributaries with the main streams within the mountain mass. This characteristic constitutes one of the main points of contrast between the Pyrenees and the Alps. In the French Alps³ the regular zoning of rocks has made possible the development of

¹ M. Sorre : *Les Pyrénées*, p. 75, 1913.

² Raoul Blanchard 'La Morphologie des Pyrénées Françaises' (*A. de G.*, 1914, p. 303).

³ cf. pp. 246, 248.

longitudinal troughs, inviting penetration to the heart of the mountains and settlement all along their courses. There is nothing comparable in the French Pyrenees. Only in Roussillon, where the High Pyrenees break down completely, do we have longitudinal streams. Zoning of the outcropping rocks can, as in the Alps, be distinguished, but the belts of soft rock exposed are so narrow and so frequently interrupted that the rivers have had no encouragement to develop. Moreover, the hydrography of the Pyrenees is still young. Although erosion has been active here much longer than in the Alps, for they were raised in Upper Eocene times, the work of reduction has been renewed owing to subsequent periods of elevation, probably recurrent; and however elaborate the former drainage system may have been, the present one has only reached a juvenile stage of development.

The Pyrenean uplands are shaped like a tadpole, with a broad, blunt head (if we ignore the Albères process) turned towards the Mediterranean, and a tapering tail towards the angle of the Bay of Biscay. In the east the build of the mountains is on massive lines. High, rounded summits running up to between 8,000 and 9,000 feet, and high, steep-edged plateaux are dominant features. Towards the centre, precipitous serrated ridges and towering crags are the rule. West of the Col de Ronceval, lower wooded ridges with more gentle slopes prevail, broken here and there by a jutting knife-edged peak. Although the general trend and graining of the Pyrenees is from east to west, the structure lines are disturbed at either end of the range and curve, in the west, round the intrusive block of Ursois in the Basque country, and in the south-east and the north-east round the ancient block of Monthoumet in the Corbières.¹ The Basque Massif appears to be but an incident in the general relief of the system, but the Corbières block would seem to be a detached remnant of the Central Massif that proved rigid enough to withstand the Pyrenean folding and to cause its waves to sheer off towards the north-east, where they form the limestone hills of Bas Languedoc and the lower Rhône valley.

The French Pyrenees may be conveniently divided into three longitudinal zones: first, as you approach from the north, the *Petites Pyrénées*, which run in a north-west-south-east direction between the Garonne and Aude basins. They consist of a number of ~~narrow~~ ridges trenched by the valley of the Ariège from south to north and deeply notched by a number of minor streams. They ~~are~~ composed of limestone, shale, and clay of Upper Cretaceous and Lower Eocene age. Westwards they disappear beneath the great masses of Late Tertiary and ancient

¹ See M. Sorre: *op. cit.*, p. 81.

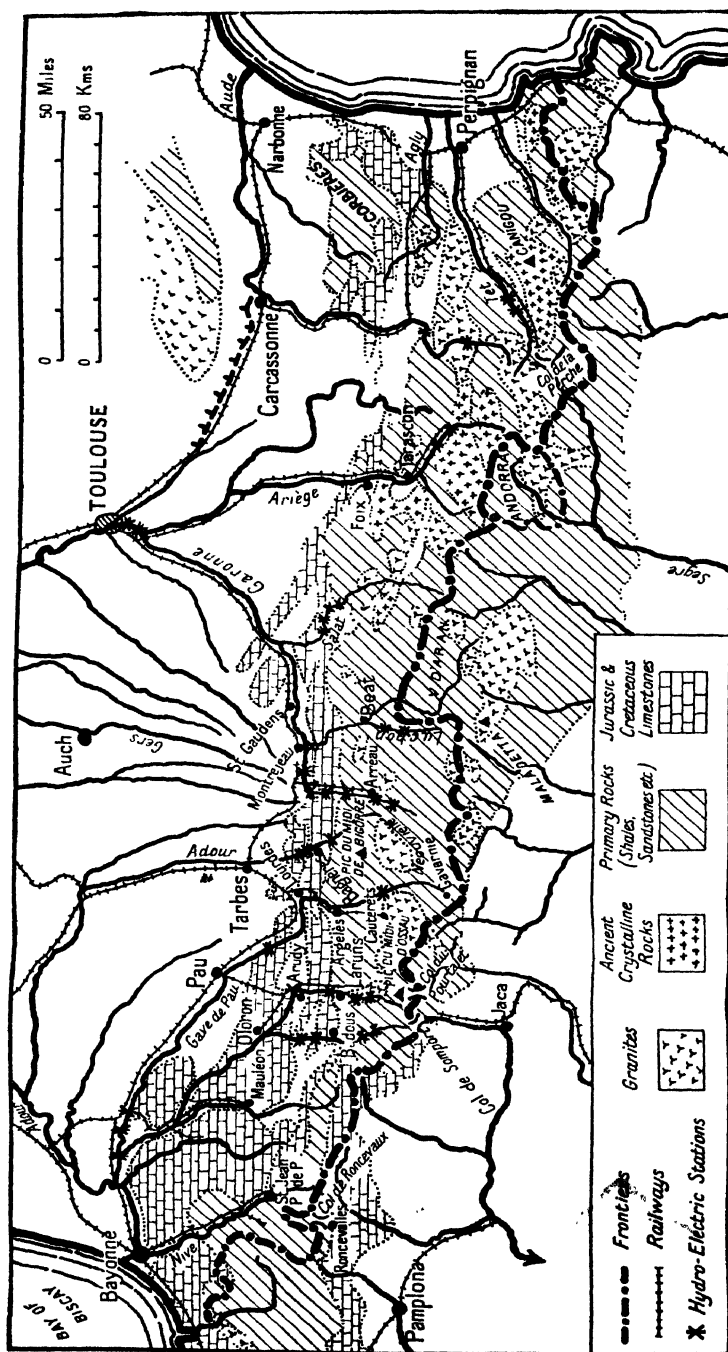


FIG. 41 THE PYRENEES SHOWING THE BROAD LITHOLOGICAL DISTRIBUTIONS (GREATLY GENERALIZED)

alluvial material that covers the southern floor of the Gascon plains, and only reappear, far to the west, in the valley of the Adour. The outer zone of the central foothills consists of a similar belt of rocks, which widens greatly westwards in the curve formed by the Gave de Pau, to form low plateaux drained by the Gave d'Oloron and its tributaries.

The Ariège Zone is perhaps geographically the most interesting feature in the structure of the region. It consists of a narrow belt of Cretaceous and Jurassic limestones, with very narrow bands of clays intercalated, and forms a conspicuous feature in the foothills, or Fore-Pyrenees, of the centre. The limestones are relatively hard, and the Pyrenean torrents trench through them in strangulated valleys, which open out suddenly, however, where they cross the beds of clay. In some cases the rivers assume a short, longitudinal course in the clay zones, but never for more than a mile or two. The development of longitudinal tributaries here is also very slight. The straight south to north course which occurs in each of the *gaves* shown in Fig. 41 and 44, brings out this zone very clearly. East of St. Gaudens the belts of limestone separate to include great masses of Primary and intrusive rocks which are drained by the Salat, Ariz, and Ariège. Farther east this limestone zone disappears as a geographical feature in the trench that separates the Pyrenees proper from the Monthoumet Massif of the Corbières.

In the region of the *gaves* west of the Garonne basin, this strip of foothills takes the form of narrow ridges separated by deep, narrow vales. It gradually peters out in the west, to reappear in the neighbourhood of St. Jean-Pied-de-Port, where it exhibits truly karstic conditions.

The Inner Primary Zone is the zone of true mountains, and is composed chiefly of Primary rocks, for the most part greatly metamorphosed. Its higher masses are generally associated with great blocks of granite and crystalline schists and gneiss, such as the Canigou, the Maladetta, and the Balaitous. The more rugged peaks and ridges are often found among the metamorphosed sedimentary rocks, as in the Carlitte, the Pic d'Aneto, the Pic du Midi de Bigorre, and the Pic du Midi d'Ossau. In the Basque country the hills of the Primary zone rise little above 1,500 feet.

Between the southern edge of the Ariège limestone zone of foothills and the Inner Primary zone of high mountains, a belt of soft rocks, chiefly of Devonian age, makes its presence marked in all the transverse valleys by the appearance of small enclosed basins, entrance and exit from which have been cut by the *gaves* in narrow, steep-sided gorges. One of the most striking of these

little basins lies in the valley of the Gave d'Aspe, with the villages of Bedous and Accous.

In addition to these erosion basins there are basins of tectonic origin of which the large basin of Cerdagne on the Spanish slopes of the high Pyrenees, in the upper basin of the Segre is a noteworthy example. Of similar origin are the plains of Roussillon and Ampurdan, to which the Mediterranean extremities of the ranges drop abruptly on either side of the Massif of Albères.

The *hydrography* of the French Pyrenees is relatively simple. With the exception of the three rivers which flow to the plain of Roussillon, all the main streams of the central primary and crystalline zones are transverse. On reaching the Ariège zone they frequently adopt a zigzag course, flowing in longitudinal valleys for a short space, in the softer rocks, before trenching the hard limestone strips in south to north courses. The map on page 220 shows the curious parallel alignment of these trenches, which is strongly marked in the region of the *gaves*.

The rivers, like the mountain system, fall into three groups—an eastern system draining from the Canigou mass to the Mediterranean, a central system draining north to the Garonne and Adour and south to the Ebro, and a western group which drains from the low Atlantic Pyrenees to the Adour and direct to the ocean. The rivers vary in type according to the rocks over which they pass, and thus we can subdivide the drainage into an elaborately articulated system in the impermeable archæan and Primary rocks of the central massif, a system characterized by straight, trenched valleys and subterranean drainage in the Ariège zone and in the Little Pyrenees and the limestone regions of Béarn and the Basque country, and, finally, the broad-valleyed streams radiating from the dejection cones at the debouchment of the rivers Neste, Adour, and Pau.

Glacial action has had a profound effect on the valley forms. Examples of this will be noted in the more detailed description, but it may be useful to summarize some of the more general effects. To-day the glaciers of the Pyrenees are insignificant, but there is evidence that, at recurrent periods, great ice rivers filled the valleys almost to their emergence on to the plain. [The glacier of the Gave de Pau was not less than 35 miles long, 2,300 feet thick at Cèdres, 3,000 at Pierrefitte and 2,600 at Argelès.] They have had a striking effect on the forms of some of the mountains; witness the famous *cirques* of Gavarnie and of the Néouvielle. There are no great lakes in the Pyrenees, but small glacial lakes hang, like jewels pendant from a necklace, in the ice-hollowed slopes of the higher mountains, as in the Vignemale or the Néouvielle. All the well-known characteristics of glaciated

mountain land are common ; U-shaped valleys, hanging valleys, over-deepened valleys, *roches moutonnées*, moraines which once held up lakes, including the great terminal moraines of the Gave de Pau with its lake remnant of the Lac de Lourdes, and that of the Gave d'Ossau at Arudy and the Neste at La Barthe.¹

CLIMATIC REGIONS. In the west climatic conditions are oceanic. Winters are mild, summers can be very hot, but the heat is usually tempered by winds from the Atlantic. The air is rarely very dry. Rainfall depends on the passage of cyclonic disturbances, which, during the autumn and winter, pass frequently between the Pyrenees and the Central Massif to the Mediterranean.² Thus north-west winds prevail during the winter half year, especially during the period from September to January. Occasional heavy thunder-storms bring the rainfall of the summer half year up to a considerable figure.

In the Mediterranean section, on the other hand, the summers are very hot, usually with a prolonged drought, and the winters are mild with occasional cold when the *tramontane* is blowing. Rain comes with the *marin*, the sea wind that blows during the passage of a depression through the western Mediterranean basin, and, with the exception of an occasional summer storm, is confined to the winter half year. The maximum rainfall occurs in autumn, as in most places on the northern Mediterranean coasts. Naturally the amount of rainfall, like the amount of sunshine, varies greatly with aspect and elevation. The enclosed valleys and basins have appreciably less rain than exposed slopes.

Human activities, closely bound up with conditions of climate and water supply, group themselves also in three transverse zones—a western section looking towards the Bay of Biscay and Bordeaux, a central block whose interests converge on Toulouse, and an eastern section which is drawn towards Perpignan and Sète and beyond them to Marseilles.

THE EASTERN PYRENEES

ROUSSILLON. The vegetation in the eastern section reflects very closely the climatic conditions. In the east the plant life of the lower areas differs little from that of Provence. We find the same extensive woods, the same *garrigue* clothing the hill slopes, where the forests have been cleared, and composed of the same type of plant : aromatic plants such as thymes and lavenders, daphne laurel, flowering broom, cistuses, and especially the prickly Kermes oak. On the crystalline rocks of the Albères, the cork oak forms extensive woods up to 1,000 feet above sea-level,

¹ See Fig. 42.

² See p. 9.

and the bush heaths flourish. The Kermes oak, with the aid of the gorse, forms impenetrable thickets here too. Higher up, in less arid conditions, the common oak (*Quercus sessiliflora*) has been able to establish itself. Chestnut woods occur in this zone on the siliceous rocks, and the undergrowth is full of bracken. Still higher the mountain pine and Scots pine form the woodland, providing a contrast to the Alps, where the larch and spruce and Arolla pine form considerable forests. Distribution of population is closely related to opportunities of cultivation. In the east this again is dependent largely on possibilities of irrigation. Of cultivated plants, the olive is characteristic of the Mediterranean lower slopes, and its cultivation is associated with that of the vine, which also flourishes on the stony, dry, warm slopes and tends to supplant the olive. In the plains irrigation has made possible a varied cultivation. In the plain of Roussillon derivation canals from the Tet and Tech irrigate large areas and the cultivation of the vine, early vegetables and fruits in the *huertas* of the *Riviera* in the lower Tet valley and of Bas Valespir along the Tech, are very profitable. Melons, aubergines, and tomatoes, early potatoes, celery, and all kinds of vegetables are grown, sheltered by lines of reeds and fruit trees from the *tramontane*. These are sent to the great distributing market of Perpignan, which has been the chief centre of Roussillon since the Middle Ages, when it was one of the important Spanish Mediterranean trading centres. Irrigation makes possible a flourishing cultivation also in the Conflent, as the middle valley of the Tet is called. The broad alluvial terraces that overlook the present valley bottom are irrigated by streams flowing from the steep valley walls. Prades, which lies at about 1,000 feet, is the market of the valley and has acquired a certain importance from its hot springs. As in all barrier lands, the position of the towns is closely related to command of roads leading to the passes.

Perpignan has a population of 68,636. The old town stands on a low hill above the Basse, just above its confluence with the Tet and seven miles from the sea. The river carries very little water here, for the bulk of it is drained off into irrigation canals, and the town was never a port. The strong citadel which guards the eastern crossing into Spain and the routes that pass round the Corbières to Narbonne and Carcassonne, was built by the Emperor Charles V and greatly strengthened by Vauban. From the citadel one may obtain a very clear picture of the irrigated plain of Roussillon, lying in its semicircle of hills, with the Corbières to the north, the great mass of the Canigou, with its ridges rising one behind the other to the south-west, and the lower granitic hills of the Albères to the south. These last, with their

rounded summits, dark forests of cork oak and dark rocks, worn and fretted by the sea into jutting promontories and rounded combes, remind one irresistibly of the coasts of the Maures in Provence. The vine clings to the lower slopes of the valleys of the Albères and forms the chief article of cultivation along the coast. Near Banyuls-sur-Mer some of the best vine in the Midi is grown.

EASTERN HIGHLANDS. If, from the basin of Roussillon, we enter the Pyrénées Orientales, by the old Catalan route, following the river Tet, we find that, as we climb, the Mediterranean cultivation gives way to the central European crops. Apple and pear take the place of the peach, vine, and fig, and the orchards become less frequent. The valley narrows above Prades, becoming gorge-like at the little fortress of Villefranche. Some miles higher up, at Olette, Mediterranean cultivation ceases; indeed, there is little cultivation at all, and it is with some relief that the traveller emerges from the narrow valley, with its tumbling torrent, into the high, green, pastoral plain. Here stands the little fortress of Mont Louis, guarding the almost level passage of the Col de la Perche, the entrance to the tectonic Tertiary basin of Cerdagne, drained by the upper valley of the Segre, which opens to the south-west. To the right and north the plateau of Mont Louis gives passage by the Col de Casteillon to the Capcir, the open highland basin of the upper Aude, a pastoral region at the foot of the Carlitte Massif. From the basin of Donnezan and from Ariégeois in the lower Aude the Capcir is cut off by high ridges and deep gorges, and it is in relatively easy communication, at least in summer, with Cerdagne. This high basin lies several hundred feet below the Capcir and is therefore less bleak; moreover, it trends southwards. The Franco-Spanish frontier traverses Cerdagne, apparently arbitrarily, but if we consult the large-scale map we see that it includes in French territory a string of villages continuous with one another and with the Mont Louis plateau. This was provided for by the Treaty of the Pyrenees of 1659, which deliberately included continuous population. The exclusion of the ancient Roman centre of Llívia, now a small village, is due to the careless wording of the Treaty. The villages of these high, level plains of Cerdagne, Capcir, and Donnezan depend for their existence largely on the pastures of the great mass of the Carlitte, with its rounded crystalline summits surmounted by great limestone peaks and its lower slopes girdled with forests of conifers. A modern narrow-gauge railway now follows the valley of the Tet over the Col de la Perche to Puigcerda, and motor-roads, supplanting the old mule-tracks, connect Perpignan, Carcassonne, and Toulouse with the Cerdagne basin and the road to Barcelona.

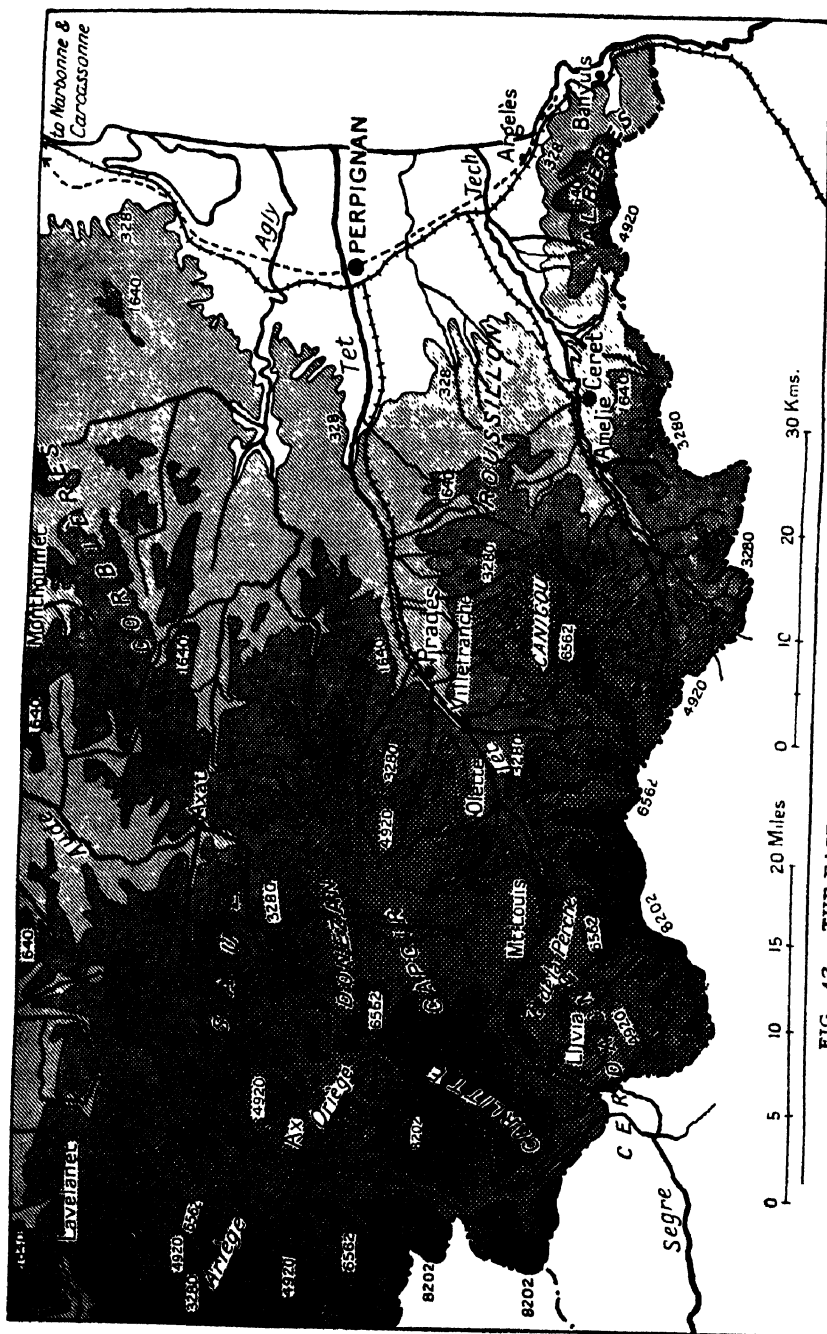


FIG. 42. THE EASTERN PYRENEES AND THE PLAIN OF ROUSSILLON

The western exit from the plain of Roussillon leads along the southern edge of the Monthoumet hills, south of the Corbières, above the fertile, irrigated plain of the Agly. It follows the upper Agly and crosses to Axat, whence *cols* lead left into the Pyrenees by the upper Aude and the upland plain of Donnezan, already mentioned, and right via the Aude gorge of Pierrellys and Quillon out into the Aude corridor and Carcassonne.

THE CENTRAL PYRENEES

The Carlitte Massif and the Pic de Recantars separate the eastern Pyrenean valleys from those of the Central Pyrenees. The Central Pyrenees drain to the Garonne and the upper Adour. Although to a certain extent this may be considered as a region of transition from Mediterranean to maritime conditions of life, the change is in many respects abrupt. It is true, as M. Sorre points out, that Mediterranean plants continue to flourish along the limestone foothills of the Ariège district, owing to the arid conditions induced by porosity of subsoil, but the passage is almost abrupt from a land of irrigation to a land of heavy spring rains and running water, from a land of wheat and vine to a land of maize and apple trees and natural meadows.

THE ARIÈGE VALLEY. The northern and western flanks of the Carlitte drain to the Ariège, the southern slopes to the Spanish river Segre. The basin of the Valira, tributary of the upper Segre, forms the little semi-independent State of Andorra, known locally as Les Vallées de Carol, from the converging valleys that take their rise in the numerous cirques that flank the rugged peaks. It is a bleak, pastoral region, whose lower slopes, turning to the south, nevertheless are terraced, irrigated, and cultivated, producing chiefly tobacco. After skirting for some five miles the Pic de Valire (Pic de Nègre), on whose western flanks it forms the boundary between France and Andorra, the Ariège drops steeply for another ten miles to Ax-les-Thermes. This little thermal station occupies the head of a basin about three miles long on which converge three typical glacial valleys from the Carlitte mass. Of these, the narrow upper Ariège valley carries the steep road which winds with many hairpin bends over the Col de Puymorens and down to Puigcerda in the upper Segre basin. The Ariège tributaries on the east, trenching the north-west of the Carlitte, drain a series of glacial lakes which form useful reservoirs. One of the tributaries, flowing from the Etang de Naguille, drops 3,000 feet over the end of a hanging valley into the broad, fertile trough of the Ariège valley and serves a

hydro-electric installation at Orlu. The valuable iron-ores which occur in the Canigou extend eastwards into the upper Ariège basin. They are mined near Ax-les-Thermes, Saurat and in many other parts of the basin. The ore is smelted and worked in the lower valleys, at Foix, Tarascon, and Pamiers. From Ax to Tarascon the Ariège flows west in a trench carved in the soft rocks which separate the central zone from the Bartélemy granite mass. This longitudinal trench is much wider than the upper valley. Its north-

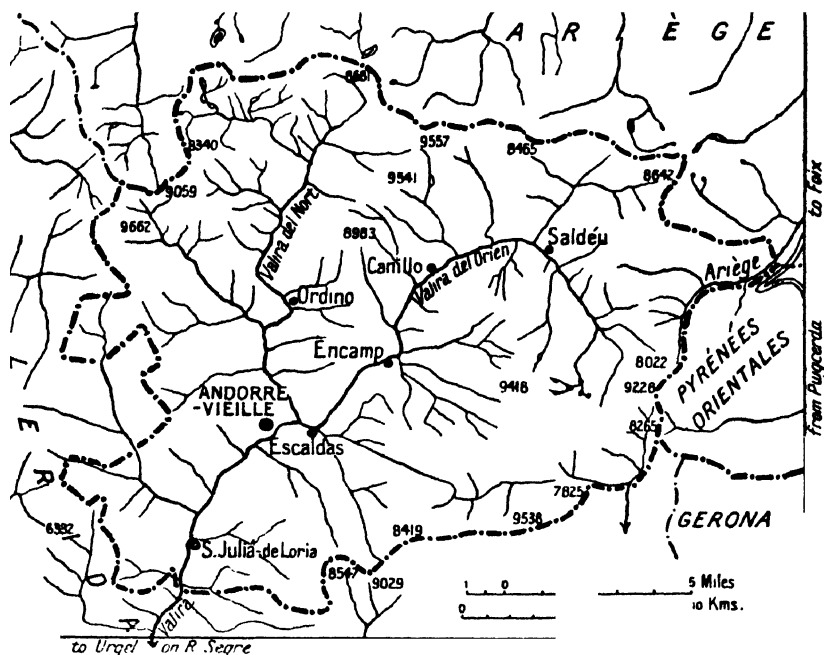


FIG. 43. THE BASIN OF ANDORRA DRAINS TO THE SPANISH SIDE OF THE PYRENEES, BUT IN SUMMER IS IN CONTACT WITH THE UPPER ARIÈGE VALLEYS.

facing slope is steep and scored by torrents from the Andorran divide; it is only where the valleys begin to open on to the plain that there is any settlement, and that is of a pastoral nature. The south-facing slope, however, carries a broad glacial ledge, 2,000 feet above the valley floor, which has been carved by longitudinal tributary streams into a subsidiary, lateral, high-level vale. This is crowded with hamlets, and cultivation is carried on up to a great height. The lower slopes on this side of the valley are also well peopled. In the summer a great part of the population of between three and four thousand souls migrate to the high

pastures in the cirques and combes on the Andorran frontier. The summer pastures, with some 30,000 sheep, bring the Andorrans into contact with the routes into the Ariège basin ; in winter, however, communication is easier with the Pays d'Urgel on the Spanish side, via the Valire gorge. This dual life of the high plains, coupled with the isolation, lies at the bottom of the dual allegiance owed by the Andorrans to France on the one hand and to Spain through the Bishop of Urgel on the other ; and the isolation alone is sufficient to account for the survival of the partial autonomy acquired by the Andorrans in the thirteenth century.

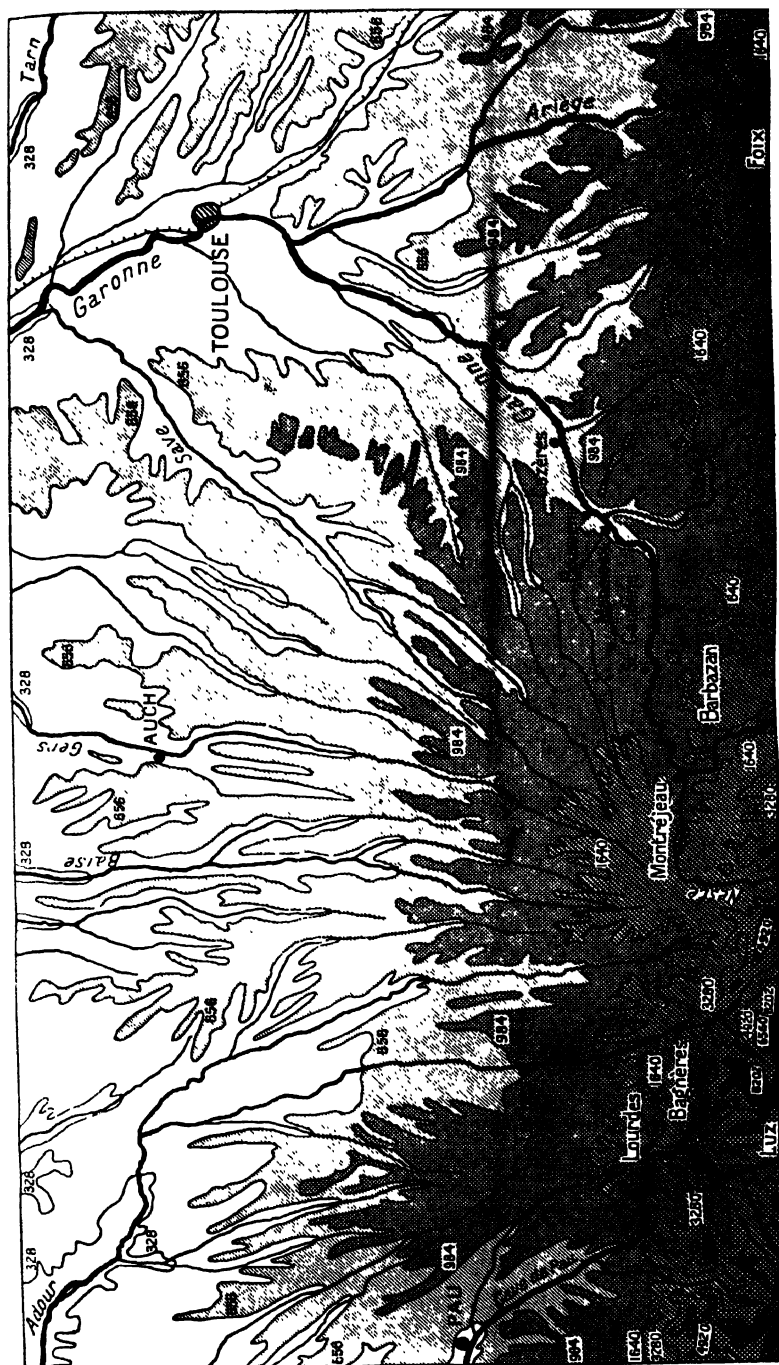
At Tarascon the valley of the Ariège widens to form another basin at the junction of the Vicdessos. This stream, whose upper basin forms a narrow enclave into Spanish territory, to the west of Andorra, drops, half-way down its course, into a narrow longitudinal trench hollowed into the secondary rocks that edge the central zone. Here, accordingly, the valley widens into a basin, surrounded as usual by small hamlets occupying the lower slopes and having in its centre Vicdessos, at the bridge over the stream. As usual, also, the south-facing slopes are agricultural, but in this case the north-facing slopes are also occupied, for there are iron mines of some little importance here. Auzat, at the upper end of the basin, has electro-metallurgical works. A narrow-gauge railway serves the valley. The basin of Tarascon, into which the Vicdessos flows, may owe its existence to a pause in the retreat of the Ariège glacier at this point.¹ The limestone rocks, whose rugged contours here contrast with the softer lines of the crystalline mass to the north, provide a relatively fertile soil, which has made possible the extension of Mediterranean flora into the area. The little town of Tarascon commands the high-road into Spain via the upper Ariège and an important longitudinal road westwards to the Salat valley, via the Col de Port. This road traverses the fertile intermontane basins of Saurat and Massat in a longitudinal trench which forms the northern boundary of the Massif of the Trois Seigneurs, one of the isolated crystalline masses thrust forward to the north of the main ridges and characteristic of the Ariège zone. There are important quarries in the mica-schists at Saurat for grindstones. This mass bears the chaplet of lakes usual in these isolated blocks, and carries the typical limestone zone on its flanks. On the other side of the Massat-Saurat depression another narrow zone of crystalline upland, with heights of over 5,500 feet drops its wooded slopes gently to the Raup valley and the Argel. Below Tarascon the Ariège cuts, in a relatively narrow valley, across the crystalline

¹ See M. Sorre, *op. cit.*, p. 115.

St. Barthélemy-Forêt de Brassac ridge and enters the limestone belt which rests upon its flanks. North-east of the St. Barthélemy mass, dolomite limestones form a small *causse* 2,500 to 3,500 feet high, part of the district known as the Pays de Sault. The steep northern slopes of this limestone upland are heavily wooded with oak and beech and fir plantations. The bare plateau itself is crossed by a road from the upper Ariège to the Aude. Where the limestone zone is composed of softer rocks a broken trench has resulted from erosion. This is drained by half a dozen different streams, but is sufficiently continuous to form a road-link between the Ariège and Aude valleys. This vale is the local representative of the sub-Pyrenean depression referred to on p. 203. Only a short section of it drains to the Ariège direct ; most of the streams follow it for a mile or two, then cut their way through the Plantaurel to the north and are gathered up by the Lhers. The basin of Lavelanet marks its largest development. The Lhers basin has a highly specialized industry in the making of horn combs, originally based on the local pastoral industry. It has also a small specialized textile industry in the Pays d'Olmes, using hydro-electric power. West of the Ariège the sub-Pyrenean depression continues in a belt of much-dissected limestone, among which bands of Liassic and Triassic Clays have been eroded to form a discontinuous vale utilized by the Foix-St. Giron railway. La Bastide de Serou in this vale is the centre for the pastoral life of the fan of head-water valleys of the Serise which drains the crystalline mass to the south.

After trenching the isolated crystalline zone north of Tarascon, the Ariège enters the glacial basin, about three miles long, of Montgaillard. Agriculture has developed here on the glacial terraces that line the basin. At the northern extremity stands Foix at the entrance to the three miles of gorge that the river cuts through the parallel ridges of the Plantaurel. This little town, quiet, in spite of the railways from Bordeaux and Toulouse which converge to pass up the Ariège valley, may find itself of some importance with an increased use of the trans-Pyrenean railway. Below Foix the Ariège crosses the Petites Pyrénées and emerges on to the plain at Pamiers.

THE UPPER GARONNE. As if to balance the Spanish Segre whose upper basin lies within the French frontier, the upper Garonne basin, the Val d'Aran, is included in Spanish territory. It is carved in the Silurian slates and lies between the Cambrian schist mass of the Crabère and the intensely glaciated granitic mass of the Sierra de Montarto, which rises in places to over 10,000 feet. The Spanish-French frontier quits the highest



ridges of the main water-parting and passes to the north along what is probably the most unbroken line of defence. This may be illustrated by comparing the narrow gorge by which the Garonne leaves the Val d'Aran to pass the frontier, with the relatively broad valley of the Naquera Pallaresa in the main ridge. In other words, although the Garonne trenches it at the relatively low level of 1,900 feet at the Col de Voudoucet, the frontier ridge is the more continuous. The Val d'Aran is a dissected and re-elevated peneplane, according to Sorre.¹ There are strong suggestions of river capture from the upper Garonne by the Spanish Noguerra, at the Port de Beret, for example, or the Port de la Bounaigo. The valley of the Garonne runs at first from east to west, widening into basins at intervals. At Viella it has dropped below 3,300 feet, at Bosost, the principal centre of its north to south section, it is at 2,300 feet; and a little beyond the frontier it flows at 1,900 feet or thereabouts. The summer pasture of the upland basin has from very early times drawn flocks of sheep from the French as well as from the Spanish side. The district resembles in many respects the State of Andorra, unlike which, however, it has been unable to retain even a semi-independence. The only good road leading down into France follows the Garonne through the Pont du Roi gorge, which the river has cut through a glacial block. On either side of the gorge wooded slopes rise to 1,300 feet. The passage itself is about 1,900 feet above sea-level. A difficult road zigzags up from Bosost in the Val d'Aran and crosses into the valley of Luchon to the spa of Bagnères de Luchon. The ice-eroded Luchon basin is drained by the river Pique in its middle course. Luchon lies at the junction of the longitudinal and transverse sections of the Pique valley. The upper longitudinal valley offers a striking example of the importance to human mountain settlement of aspect, and also illustrates the considerable role played by ice in widening and deepening valleys and in providing ledges, shoulders, and terraces on which soil can accumulate and thus permit of cultivation. The north slope of the upper Pique valley exhibits a sunny morainic ledge, which is crowded with villages. Near Luchon iron is mined and is worked at St. Gaudens. From Pont du Roi to Beat, the Garonne valley is wide in the softer Primary rocks. At Beat the river cuts through a band of hard marble in a narrow defile, at the bottom of which the elongated town is squeezed against the walls of the gorge. The marble is quarried here and in the parallel valley of the Neste d'Aure. Below the gorge the broad slate basin of Parignac opens out, well cultivated, with vines on the sunny slopes. A short course through a wooded limestone barrier and the river emerges from

¹ M. Sorre, *op. cit.*, p. 126.

the central Pyrenean zone into the outer limestone zone by the broad alluvial basin of Siradin, with the usual morainic terraces, through which it carves an uncertain course. An ill-defined belt of softer Cretaceous rocks now provides a zone of relatively open country in the midst of the broken, forested plateau of limestone. This zone the Garonne now traverses via the basin of Barbazon on its way to the great pre-Pyrenean trench at Montrejeau. At this town it receives the Neste, which approaches along the trench from the west, and joins the eastward course of its tributary, accompanied by the national road and railway. It passes the quiet little town of St. Gaudens, and at Mancieux receives the Salat where it emerges in its turn from the limestone zone. The lower Salat has a number of small hydro-electric installations which supply power for paper factories. The broad vale through which the combined waters flow is dominated to the south by the wooded scarp of Cretaceous limestone. At Boussens the valley narrows as the river enters the Little Pyrenees, which it traverses between heights that rise to 1,300 and 2,000 feet on either hand, that is to say, 600 or 700 feet above the valley floor. At Cazères the Garonne emerges from these limestone hills and becomes a river of the plains. It enters the Tertiary plateau 600 feet high, and covered with ancient alluvium, in which, with the help of its tributaries, it has scored a tremendous trench six miles wide. The numerous and powerful left-hand tributaries have built up *doabs* that have pushed the river to the extreme eastern edge of the trench; twenty-five miles farther downstream the Garonne reaches Toulouse, which may be considered the focusing point of the Central Pyrenees.

To complete the description of the upper Pyrenean-Garonne basin we must return to the mountains and briefly trace the course of its most westerly confluent, the Neste d'Aure. This stream has carved an upper basin, a dozen miles wide, into the crystalline mass that separates it from the head-waters of the Gave de Pau. Its head-waters, separated by spurs some 8,000 feet high, drain a series of great cirques, some of them with glaciers, arranged in a horseshoe, and with the usual accompaniment of glacial lakes—especially numerous on the Neouvielle Massif. The main head-waters are drawn together before the river drops down to the basin of Vielle Aure at St. Lary, which marks the final stand of a great glacier which came down from the Neouvielle. The festoon of lakes round the Neouvielle provide one of the most important reservoirs of water for electric power that the Pyrenees offer. The Aure basin resembles the other Central Pyrenean basins, with their water-meadows and tall poplars, cultivation on alluvial fans, conifers on the middle slopes, and, higher up, the

vivid green pasture dotted with shepherds' huts. At Arreau, by a spectacular descent, there enters the road from the Col d'Aspin, which links the Aure valley with that of the Adour, some three miles towards the west. We leave behind us the regions of conifers now, and all the steeper slopes are clothed with beeches. Arreau, which was once the capital of an independent community of the four valleys which converge upon it, owes its significance to-day to its important hydro-electric station.

Below Arreau, *gave*, road, and a single-track railway traverse a three-mile gorge which opens out into a steep-sided, flat-bottomed valley at Beyre de Jument. Here a canal takes off from the Neste d'Aure and follows the side of the valley to carry irrigation water to the alluvial fans that lie to the north.¹ At St. Bertrand the valley begins to widen towards the pre-Pyrenean trench into which it turns a few miles farther down, diverted by the enormous masses of detritus that its own waters have deposited in the past, largely as a result of deforestation.

West of the Neste d'Aure, the crystalline Massif of the Pic du Midi du Bigorre, over 6,500 feet high, advance-guard of the central zone of the Pyrenees, juts forward to overhang the edge of the plain of Aquitaine, forming a great watershed between streams flowing to the Garonne and those flowing to the Adour. On its northern front rise the head-waters of the Adour, issuing from the usual festoon of glacial lakes that lie in the shadow of the steep-walled cirques. The Pic itself, nearly 9,500 feet high, is a striking feature, especially when seen from the north. A depression between this northward-jutting Massif and the still higher southern block of the Neouvielle, over 10,000 feet, drains east to the Adour and west to the Gave de Pau, the two stream valleys being connected by a twisting road over the Col de Tourmalet, about 6,850 feet. From the point of view of human geography, the chief rôle of the upper Adour is to form a link by this *col* and the Col d'Aspin with the populous valleys of the Gave de Pau and the Neste d'Aure. From either *col* one descends the upper valley of the Adour through forests of pine and pastures, irrigated fields and meadows accompanying the streams. The abundance of water provides a plentiful forage for cattle in winter. Above Campan, whose inhabitants add quarrying to their pastoral and agricultural activities, the valley widens and the river escapes from the mountain and forest through a narrow gorge in the outer limestone zone. Bagnères de Bigorre stands at the entrance to the broadening agricultural vale that

¹ See p. 205.

the Adour now follows on its twelve miles course to Tarbes. This little town, with its spa, is the market centre of the prosperous Bigorrais, which has numerous comfortable villages occupying the belt of broken country stretching towards Lourdes and Tarbes. Marble from the gorge above Campan is worked at Bagnères, and there are still traces of a formerly well-known woollen industry.

THE GAVE DE PAU. With the Gave de Pau we reach the

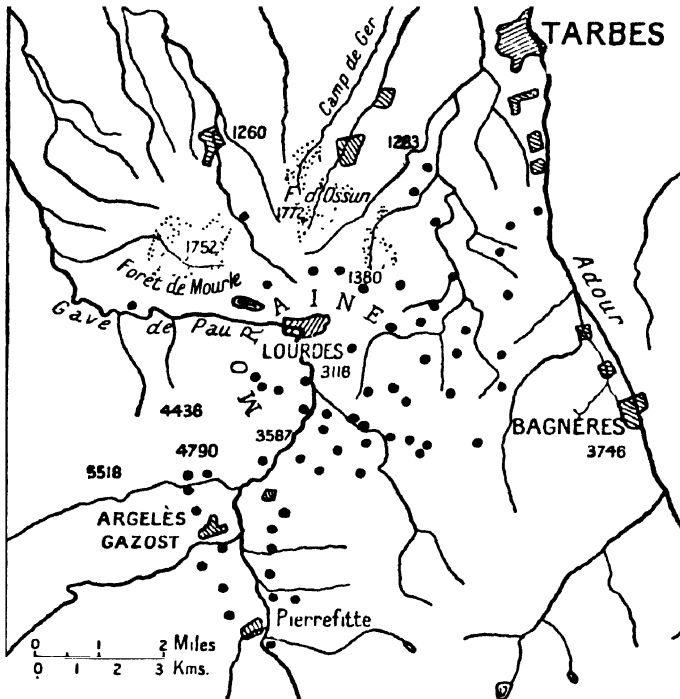


FIG. 45. THE GAVE DE PAU SHOWING THE POSITION OF THE GREAT MORAINIC DEPOSITS AND THE DIVERGING VALLEY WAYS

most frequented, the most densely-populated, the most beautiful—one is almost tempted to say the most theatrical—of the Pyrenean river basins. This is essentially the valley of the tourist! Brèche de Roland, Cirque de Gavarnie, Cauterets, Lourdes, Pau—these are all household words! The exceptional populousness and popularity of the valley is due indirectly to the *gave*. In the first place the *gave* glaciers provided the broad and fertile vale of Pierrefitte Argelès and secondly the immense amount of detritus which their glacial waters deposited to the

north of the basin of Lourdes, diverted the river to the west and left its old channels to east and north to form so many converging routes. The site was bound to give rise to a route centre and fortress ; the famous grotto of Bernadette has made it a pilgrimage and tourist centre.

The upper catchment area of the Gave de Pau in the Vignemale, the Mont Perdu, and the Neouvielle masses, covers over 200 square miles, and includes some of the highest peaks in the Pyrenees, rising to over 10,000 feet. The main stream of the *gave* rises in the Cirque de Gavarnie on the north-west flanks of the Mont Perdu in the Massif of the Tres Sorores. The walls of the cirque rise to an encircling crest of 10,000 feet.

At Cèdres a group of streams converge from the frontier heights, making the village the control point of the life of the irrigated hanging valleys. Dropping to Luz, the *gave* enters a scooped-out detritus-floored basin, down whose sides innumerable streams pour, to be utilized by the peasants to irrigate their fields. This basin receives also the tumultuous Bastan which drains the north and west slopes of the Neouvielle, and on whose banks stands the village of Barèges, which has given its name not only to the district, but also to a fine woollen material formerly well known in this country. The little woollen industry which still persists at Luz is based on the high pastures of the frontier, which at one time, by treaty, extended into Aragon. The syndicate which owns the springs at Barèges is the modern representative of the ancient pastoral community of the upper basin of the Gave de Pau, which owned pastures, forests, and springs, and whose relations with neighbouring communes on both sides of the frontier were sometimes of the stormiest.¹

Cauterets had a similar origin. Six miles of steep-sided gorge links the basin of Luz with that of Pierrefitte-Argetès by a road constructed not without difficulty in the eighteenth century. Here comes in the Gave de Cauterets whose valley carries an electric light-railway to the Spa and serves also some silver lead mines. The tributary waters of the *gave* are enslaved and carried in great flumes down the valley to feed the industries of Luz. Cauterets has 1,020 inhabitants, but the number of visitors each summer runs into six figures. Of recent years the increasing propensities of the French for *le sport* have resulted in the development of winter activities at the station. The basin of Pierrefitte-Argetès is being to some extent industrialized by the hydro-electric installation of the Compagnie du Midi. Above the little twin town of Pierrefitte-Nestalas there are nitrate works that rendered good service during the war of 1914-18. The typical

¹ M. Sorre, p. 152.

intermontane basin is about ten miles long and narrows gradually to the north. Its upper slopes carry chestnut woods ; its lower slopes are festooned with villages, among which Argelès-Gazost, the administrative centre, is also a spa. The modern town spreads its park and casino and villas over the level, verdant plain, but the picturesque old town climbs the steep wall of the basin, its tall houses, with projecting eaves and wooden balconies, rising one above the other, forming a strong contrast to the modern tourist resort.

About seven miles below Argelès the Gave de Pau, after crossing the outer limestone zone of the Pyrenees in a narrow valley, emerges on to the plain of Lourdes. Lourdes is an extraordinary hydrographical centre. To the north of the town a great cone of glacial material—the Cone de Ger—rises to 1,870 feet, throwing its waters off northwards to the Adour. On either side of the cone depressions lead north-west to Pau and north-east to Tarbes. The north-eastern depression probably represents a former valley of the Gave de Pau. It carries the national road and the railway. Westwards, the *gave*, turning sharply to the left, follows a line of weakness between the upper and middle Cretaceous beds, cutting a longitudinal trench followed by the Lourdes-Bayonne railway. Eastward another derelict valley carries a road to the *col* of Louerup, which leads down into the upper basin of the Adour below Bagnères de Bigorre. The situation of the old market town of Lourdes is picturesque. The readily-dissolved limestone has provided the famous grotto and the miraculous spring ; excellent communications facilitate pilgrimages on a large scale from all parts of Europe, and initiative and business acumen, greatly aided by the advent of the motor charabanc, have exploited to the full the attractions of the neighbourhood.

Tarbes is a flourishing little market town on the Adour, where it emerges from the Tertiary hill country on to the plain of ancient alluvium. It is the chief tanning centre of the grazing districts of Hautes Pyrénées, and specializes in the manufacture of patent leather. Kid- and lamb-skins are sent from this area to the glove factories of Grenoble and Millau. South of Tarbes the Tertiary rocks form a region of fertility and relatively dense population, in marked contrast to the barren limestone area south-west of Lourdes. Tarbes is an important railway junction for the Pyrenees. It unites the converging lines of the Pyrenean valleys and links them with Toulouse, Bordeaux, and Bayonne.

The *Val d'Ossau* and the *Val d'Aspe* complete the series of *gave* valleys of the Central Pyrenees. The Pic du Midi d'Ossau, raising its jagged crag of volcanic rock to 9,450 feet above

sea-level, is the last of the great mountain masses to the west. The road from the Col du Pourtalet, which leads via Biescas down to the Jaca railway in the Tulivana valley, skirts the eastern

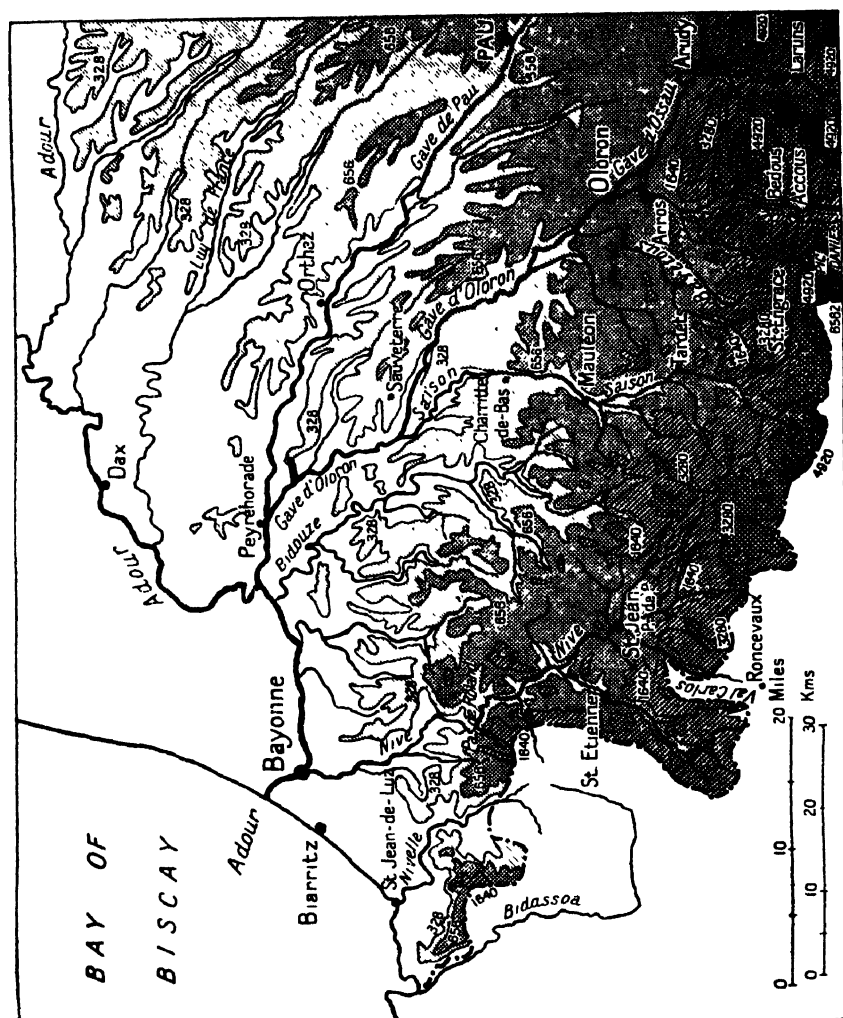


FIG. 46. THE WESTERN PYRENEES

flanks of the mass in a wild and desolate valley among the pinkish sandstone rocks. The lower slopes, as one descends the Val d'Ossau, where the *gave* cuts into the granite, are wooded with beech and fir, and the upper slopes are green with sheep pasture even in the driest summer. At Gabas the road descends to the valley bottom which widens just above the steep descent into the

main valley of the Gave d'Ossau. The change in gradient and the narrowness of the main valley, which is dammed at Gabas, is being utilized to provide an important hydro-electric station. Quartz quarries in the neighbourhood provide cement for the works. The road winds down along the side of the steep, narrow, U-shaped valley. Terraced precipices of markedly striated white limestone rise above purple, slaty cliffs covered with woods. At Eaux Chaudes, a little watering-place, there are other hydro-electric works. Above Laruns, three miles farther down, the road pierces the limestone rock in a long, narrow gorge, cut in a mass of rock¹ which blocks the over-deepened glacial valley, and emerges into a beautiful cirque whose vivid green and gold colouring delights the eye after the long, unbroken descent through the sombre valley. The Gave d'Ossau, which tunnels the limestone rock, emerges from a cave to flow across the verdant, richly-cultivated plain. Laruns marks the end of the region of forest and pasture. If one happens to be at Laruns in the first weeks in September one hears the musical sound of the cow-bells as the herds from the high mountain pastures converge on the little town; great maize-coloured milch cows slowly emerge in groups of a dozen, twenty, thirty, or more from the narrow valleys on to the market-place, where their owners come to claim them and drive them to their winter quarters in the surrounding villages. The Val d'Ossau offers perhaps the most abrupt descent from the frontier heights of the Pyrenees to the lowland, for Laruns lies only 1,700 feet above the sea, eleven miles from Arudy, on the outer edge of the Pyrenees. The valley drops 4,300 feet in a little over a dozen miles. The distance traversed by road in descending the valley is nearly double this. The French Pyrenees have narrowed here to about half the width they exhibit in the centre and east.

Below Laruns, the valley of the Gave d'Ossau is relatively wide, and in the eight miles of its traverse of the outer limestone ridge has eleven villages or hamlets with white, slate-roofed houses lining its slopes. Here we have the agricultural and lower pastoral region that lives in a kind of symbiotic union with the woodlands and high grazing grounds of the upper valley. Fields of tall maize and emerald green meadows now follow the *gave*, relieved by fields of wheat. At Arudy the Gave d'Ossau turns west on leaving the limestone pre-Pyrenees, following the example of the Gave de Pau, and skirts the southern edge of the broad trench, carved by the Ossau glacier, that leads to Oloron-St. Marie, which lies in the plain at 600 feet above sea-level. The *gave* hugs the foot of the pre-Pyrenees to the south of the

¹ A *verrou*.

trench, which, three and a half miles to the north, is walled in by the steep edge of a morainic mass. The little market town has a population of 8,529, and has small textile (wool) and tanning industries. In the town the Ossau is joined by the Aspe, which has followed a parallel but very dissimilar course from the Spanish frontier. The Aspe falls in a series of steps from the frontier at the *Col de Somport* to Arros, where it finally quits the mountains. From Urdos, to which the torrent drops in the first nine miles of its course, the valley alternately narrows to a gorge and widens to little fertile, cultivated basins, of which the most important is the Bedous-Accous basin already mentioned. What the mountains of the head-waters of the Gaves of Ossau and Aspe lack in majesty they make up for in the beauty of the colouring of the rocks. The striking contrast of the magenta of the Triassic sandstone with the snowy white of the Devonian limestones and the vivid green of the upland pastures which continue up to the *cols*, is well worth the climb to the pass. Large flocks of sheep may be seen grazing on the slopes, and shepherds' huts are dotted about in the hollows. At Urdos the *gave* is dammed for the power station, for the new electric railway which passes under the Col de Somport and descends to Jaca in the upper Aragon valley. In the gorge, just below Urdos, is the fort of Pourtalet, where galleries and barracks capable of accommodating 3,000 men have been cut out of the solid rock. Below Urdos the little basin of Borce, Etsaut, and Eygun mark stages in the work of the Aspe glacier. Below Bellocq the river enters a narrow gorge, trenched through a long ridge of limestone, which separates the upper from the lower Aspe basin. The New Transpyrenean railway passes through the gorge with the help of a couple of tunnels. Just where the gorge opens suddenly on to the Bedous-Accous basin there is another hydro-electric station. The Bedous basin widens immediately at the exit from the gorge to a width of a mile. It is about three miles long and lies at 1,370 feet above sea-level. It marks the final stage of the former glacier. Below the basin there are no more glacial widenings, and as a result the valley is given over to pastoral industries. The bare, precipitous rocks at the head of the basin contrast strongly with the warm tones of the bracken-covered slopes below. The floor is devoted to the cultivation of rye, maize, etc., and to pasture, and the hill slopes are cultivated and terraced. Enclosed fields occur below and between the woods and crags. A number of prosperous villages line the basin. Bedous, at the northern outlet, has a population of about 650. The Aspe now winds through the limestone ridges of the pre-Pyrenees in a narrow

valley. The villages are few and their houses rise for want of space in tiers above the narrow road that follows the river. Here the steeper slopes are covered with turf and light woods of mixed deciduous trees. In the hollows between the wooded slopes the narrow fields of vivid green pasture, one above the other, are carefully hedged. The farms lie high on the slopes. The Aspe crosses great knife-edged ridges of limestone, which rise above hills whose slopes are wooded or bracken-covered. In the late summer and autumn the bracken is all cut by hand and stacked for litter, thus giving an opportunity for the grass to grow for the sheep in the autumn and spring. The fine grass of the irrigated meadows is cut short for hay with the scythe. At Escot there is another power station. The sound of running water is everywhere, mingled with the music of the cow-bells. At Lurbe the plain of the Aspe opens and gradually widens for six miles towards Oloron. A long, low ridge separates its valley from the converging Gave d'Ossau. Oloron is a composite town including three entities. The old fortified *cote* of St. Croix, dating from the eleventh century, stands at the extremity of the ridge that lies between the converging Gaves of Ossau and Aspe. This was the site of a Roman citadel which guarded the pass of the Summus Portus (Somport) leading to Caesarea Augusta (Saragossa). The church of Ste. Marie lies on the left side of the Aspe valley; Oloron proper lies on the right bank of the Gave d'Ossau. The population of the three sections amounts to about 10,300. Between Oloron and Mauléon to the west stretches the limestone plateau of Barcus with an average level of about 2,000 feet. The region is sparsely populated and is given over to oak and chestnut woods. South-west from Oloron a road, accompanied by a light railway, leads across the limestone plateau into the broad vale of the Gave de Mauléon.

We are now in the transition region between the Central and Western Pyrenees. The greenness of the vegetation becomes if possible more accentuated. The pastures in the valley are vivid and the poplars which one always associates with these Pyrenean basins stand out against them in dark, rigid lines. Beyond the oak forests climb the slopes between the small fields enclosed in nut hedges, or give place to a carpet of bracken, tender green in spring but burnt a bright red-brown in late summer. Towards the south the limestone hills rise higher and are capped here and there with jagged peaks and beyond, ridge after ridge, like wave-crests shutting in the horizon, the high Pyrenees.

The basins of Tardets and Mauléon in the course of the *gave* have been worn deep into the soft beds of Cretaceous limestone,

marls, and conglomerates, and have been floored with thick deposits of alluvium. These ancient beds of alluvium have been trenched deep by the streams, and now lie in broad terraces high above the valley bottoms.

The *basin of Tardets* is crowded with hamlets to a height of 1,600 feet. Orchards of peach and apricot alternate with the vineyards, and fields of maize occupy the lower ground. Walls and farm buildings are constructed of the large, smooth pebbles collected from the *gave*, but prosperous two-storied whitewashed houses with slate roofs add to the cheerfulness of the landscape. Here we begin to see the Basque influence in the curious union of farm-house and stable under the same roof, which descends at a steep angle from the house gable and then slopes out gently to cover the lower farm buildings. Mauléon lies in a narrowing of the valley, between the limestone hills, at 460 feet above sea-level.

Below Oloron and Mauléon the two *gaves* converge on Sauveterre, following broad, busy valleys in the Cretaceous limestone, where the resources from the cultivation of wheat, maize, and fruit are augmented by a number of little industries, from a woollen industry to which is allied the manufacture of the beret, the national male head-dress of the Basque country, to the tanning of hides. The more torrential Gave de Mauléon has a hydro-electric installation at Charritte de Bas, five miles below Mauléon. The three *gave* valleys of Oloron, Mauléon, and Pau, converging towards Peyrehorade, contain the life of the Béarnais. The Gave de Pau above Orthez and below Pau lies, strictly speaking, outside the Pyrenees, but the Gave d'Oloron and the Gave de Mauléon lie within the limestone foothills which, west of Oloron, spring northward for some thirty miles and actually reach the Gave de Pau below Orthez.

As we proceed westward the character of the fore-mountains of the Pyrenees changes little. We have the same dissected limestone plateau, the same deeply-trenched valleys with heavily wooded or bracken-covered slopes. The high Pyrenees, on the other hand, drop rapidly towards the Atlantic and the trend of the ridges turns towards the north-west.

THE WESTERN PYRENEES

The Pic d'Anie marks the western extremity of the central zone of the High Pyrenees. From this point for three miles the watershed is formed by upper Cretaceous limestones and nowhere reaches 6,500 feet, except in the Pic d'Orhy. These limestones have worn into high-level plateaux rather than ridges, but here and there rugged masses and peaks rise from the sweeping

plateaux. A slightly lower zone, composed of Carboniferous limestones, is marked by two basins in which Triassic marls and soft limestones have been preserved. These basins of Larrau and St. Engrâce receive the waters from the high Cretaceous limestone plateau and pass them on as the two head-streams of the Gave de Mauléon (or the Saison). In these two small basins is concentrated the life of the Haute Soule, as the upper basin of the Saison is called. The uplands that separate them are covered with beech forest, and communications are difficult.

At the confluence of the two head-streams, where the united river enters a gorge it has cut in a narrow zone of Cretaceous limestone, is a hydro-electric station which supplies power to the basin of Tardets below. This basin is carved in the soft rocks belonging to the lower Cretaceous series. It differs little in appearance from many of the intermontane basins of the Pyrenees. The *gave*, with its swift waters flowing among great masses of boulders, the lines of Lombardy poplars, the scraggy oak trees in the hedgerows, which at a casual glance are indistinguishable from the neglected hedgerows in south-eastern England, the walls and farm buildings constructed of rounded stones from the *gave*, the watered, vivid green meadows in the valley bottoms, are all characteristic of the western Pyrenean basins. Maize and vine grow abundantly, while peach orchards and wooded slopes with walnut, chestnut, and acacia are common sights. The little white houses, with their slate roofs, are very different from the heavy roofed houses of the Basques. A score of little villages and hamlets depend on the cultivation of the river terraces of this basin and on the grazing and timber of the surrounding uplands. Tardets is the largest settlement, with 1,200 inhabitants. South of the Tardets basin of the Middle Soule lie the high limestone plains of the Baretous and the forest of Arbailles. These hills, with smooth contours and rounded summits, form good grazing land, and there is still a fair amount of timber in the mixed woodland. This type of country continues westwards in a broad belt as far as St. Jean-Pied-de-Port and then northwards round the Primary Massif of the Basque country. West of the Saison it is drained by the Bidouze, whose valley, carved in an exposure of soft marly rocks, forms a highway between Sauveterre at the junction of the Saison and Oloron and St. Jean-Pied-de-Port. A belt of marly shales accounts for the prosperous basin of St. Palais, where Bidouze, Oloron, and Saison draw together, but the plateau continues in low hills known as *landes*, once forested, but now affording nothing but scant herbage—the Landes of the Bois de Hasparan and of the Bois de Mixe, for example. We have now descended to a level

of less than 650 feet. The *Oloron* trenches the upland in a broad, flat-bottomed valley flowing in a stony flood-plain. The villages and hamlets cling to the terraces, which are intensively cultivated. This low plateau ends abruptly above the pre-Pyrenean trench through which the Gave de Pau and the Adour flow to the Atlantic.

THE BASQUE PAYS. The *Nive*, like the *Saison*, rises in the high plateaux of Upper Cretaceous limestone, but has a smaller drainage basin there. It drops quickly to the Triassic basin of Cize, which corresponds to the Low Soule basin of the *Saison* at Tardets. Here is the ancient fortress of St. Jean-Pied-de-Port, a picturesque little town guarding the route that comes down from the frontier via the Col d'Ibaneta or Roncevaux. Sauveterre and St. Jean-Pied-de-Port were stations on the main route over the pass of Roncevaux from Sauveterre and Dax to Pampe-luna. The road to Sauveterre is the natural northern outlet from the basin of Cize. The river finds its exit via a narrow gorge of recent geological date ; but the way lies open and easy by an older line of drainage, to the valley of the Bidouze and the *Oloron*. But for the *Nive* valley railway and the motor-coaches, the eastern part of the Basque Pays would still have its principal commercial relations with Béarn.

The *Nive* valley is essentially Basque. The houses with their carved wooden balconies and their brightly-coloured shutters, the farms with their high gabled roofs which extend a sheltering wing to cover the outbuildings, the fallow, dark-eyed folk, with their long heads and faces and slender forms, the string shoes taking the place of the ubiquitous French sabot, the *pelota* courts in the village squares—all these things attract attention, apart from the strange speech ! A certain almost truculent gaiety seems to characterize the bearing of the Basque peasant, at least to the eye of the foreigner, and he seems to be in accord with the cheerful aspect of his sunny and well-watered valleys which open to the balmy winds of the Atlantic.

The motor-coaches are playing an important part in developing the tourist and health resorts of the Pyrenees and in linking up the transverse valleys with one another. Motor transport has gone hand in hand with road improvement, and there is a regular service of coaches during the milder season from end to end of the Pyrenees. From *Oloron* via Mauléon, the Col d'Osquich, St. Jean-Pied-de-Port and Cambo, there is a fairly direct route to the Bay of Biscay, through the Basses Pyrénées. Cambo is a watering-place of growing importance with a population of about 1,400. It lies on the *Nive* below the old village, which stands

on a bluff overlooking the river. The western end of the French Pyrenees, in spite of their decreasing height, are much accidented, and, with their increasing richness of verdure, are extremely picturesque. They form a valuable background to the seaside resorts, which stretch from St. Jean-de-Luz through Biarritz to Bayonne and beyond along the coast of the Landes. The *ria*-like tidal estuaries of the Bidassoa, which forms the frontier for half a dozen miles, and of the Nivelle, which opens between rocky promontories, remind one of the coast of Brittany, and the invasion of English-speaking tourists during the summer enhances the resemblance. The fact that Bordeaux was the American base during the War has extended the *clientèle* of these resorts to the opposite shores of the Atlantic.

Bayonne, on the Adour, with its ancient bastions and more modern fortresses, controls the routes along the coast and via the western passes into Spain. It has retained its individuality, probably owing to the fact that the Adour debouches through the sand dunes of the Landes, which has prevented the development of seaside resorts at the mouth. The position of the old town is interesting. It lies on the south bank of the Adour, where the river narrows as it passes through the limestone belt about a mile in breadth which separates the pre-Pyrenean trench from the Landes. At this point the Nivelle joins the Adour, and the old town lies in the angle between the two rivers. The river is navigable for small craft up to the confluence of the Bidouze, about sixty miles from the sea. At Bayonne the average depth at slack water is twenty feet, and at low water the depth may decrease to a little over three feet. During the summer, the maximum draught of vessels at high tide is twenty-four feet, but in winter it is only about twenty. The port has suffered from the lack of good rail communication with Madrid. The electrification of the lines of the Midi and the construction of the electric railway to Pampeluna by way of the Val Carlos would no doubt increase the importance of the town as a centre of traffic, but the mouth of the Adour would need costly engineering works to make of Bayonne a modern port.

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the whole of the coast between Biarritz and Rochefort is formed of loose sandy deposits.

The geographical basin of to-day began to make its appear-

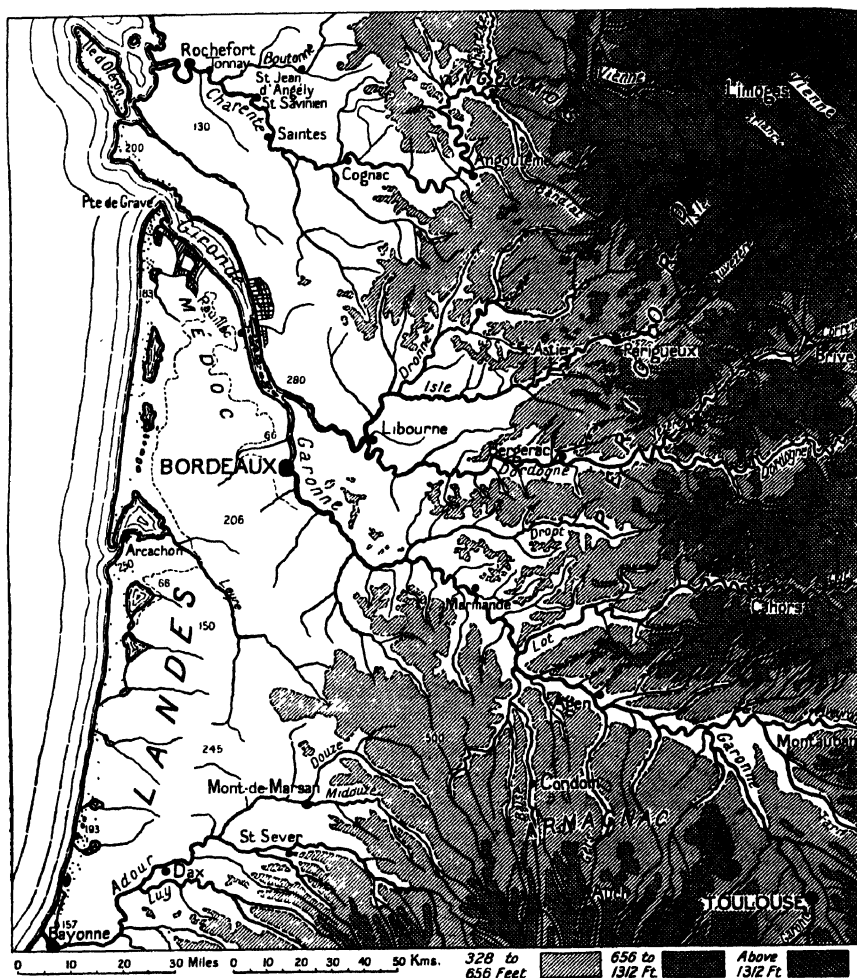


FIG. 47. THE BASIN OF AQUITAINE. THE 60-FOOT CONTOUR LINE HAS BEEN INSERTED TO BRING OUT THE SLIGHTLY RAISED WINE DISTRICT OF MÉDOC BETWEEN THE SAND-DUNES AND THE ESTUARY.

ance with the upfolding of the Pyrenees in early Tertiary times. The development of great faults let down the floor of the basin along the edge of the Central Massif. The strait of Lauraguais, which had allowed marine communication between Atlantic and

Mediterranean, was closed. The sea gradually withdrew from the gulf of Gascony, which occupied the depression at the foot of the Pyrenees. At the same time enormous thicknesses of detritus were poured down from the surrounding highlands. The deposition of stony, sandy, or argillaceous material continued through Quaternary times. Huge alluvial fans were formed, as in the Lannemezan, and stretches of dune land as in the Landes. The result of subsequent erosion has been the formation of a rolling country of low plateau and vale with a rim of higher plateau in which the rivers trench deep valleys. The loose Quaternary deposits have been eroded to form terraces at various levels in the basins of all the rivers.

Generally speaking, the Upper Tertiary rocks, with their *limon* covering, are extremely fertile. The soils of the Quaternary tands, unless irrigated, form heathland or forest. The valley serraces are usually under cultivation, and the flood-plains form pasture or are used for producing fodder crops or vegetables, under irrigation. The Lower Tertiary soils in Albigeois and Lauraguais tend to be sandy, and are often wooded. Much of this land is nevertheless under cultivation. The sandy limestone of the Upper Cretaceous rocks forms excellent crop land, although here and there a porous soil makes cultivation difficult. The higher areas form a kind of champagne country, e.g. the Champagne south-west of Angoulême.

The basin sends an extension northwards into Poitou, where the Cretaceous limestone country continues without any intervening Gault plain, into the Oolitic limestone ridge of Angoumois and Niortais.

Whatever the subsoil, so propitious is the climate that almost the whole of the Aquitaine basin is under cultivation. Sheltered from the north and east, open to the moist winds of the Atlantic, sufficiently low-lying to avoid excessive rainfall, Aquitaine has a climate which has been frequently described as balmy; and that is indeed the expression that occurs to one in this atmosphere, which is mild without being enervating and where the winds are scented with the aroma of the pines of the Landes. The broken nature of the country prevents the oceanic winds from sweeping too violently across the land. The prevalent limestone subsoil ensures a good drainage of the soil except in the flood-plains. It is small wonder that Aquitaine is one of the most agriculturally productive regions of France.

THE GARONNE BASIN. We have traced the course of the Garonne and its tributary the Ariège as far as their exit from the Pyrenean foothills. They pass immediately into broad plains sometimes as much as six miles wide, which are trenched into the

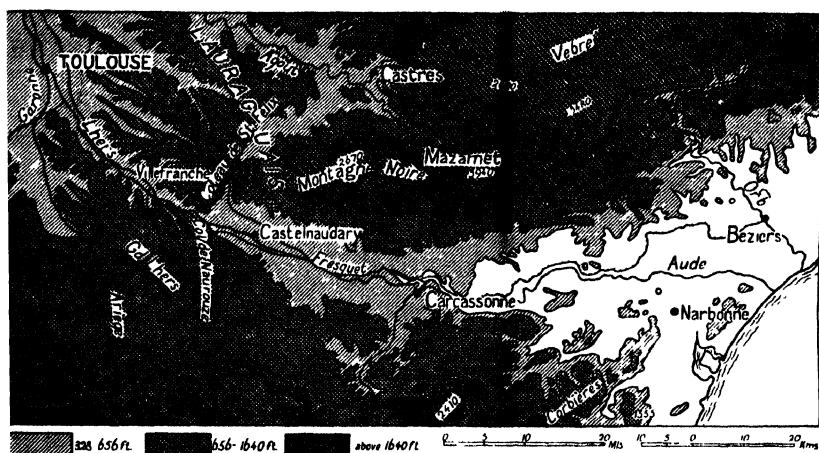
soft Tertiary rocks. Roads and railways make use of these trenches. The main river usually hugs one side of the trench, cutting into the soft rock and gradually widening the plain. Tributary streams have formed long *doabs*. Minor streams trench the edges of the low plateau and then turn, almost at right angles, to flow parallel with the main river in the flood-plain before joining it. Owing partly to the danger of floods, partly to the coarse nature of the soil laid down by the Pyrenean streams, river plains have but a small population. The few settlements cling mainly to the edges. The low Tertiary plateau, however, is covered thickly, at intervals of about a mile, with farms and hamlets, for the friable limestone weathers into good soil and even at an elevation of 1,000 feet most of the land is under cultivation. The steep bluffs, however, overhanging the northward-streaming tributaries that cross the Lannemezan, are wooded, or covered with heath and gorse, for the limestone is overlain here by sandy deposits. The Lower Tertiary sandy rocks to the east are higher, the ridges rising to 1,000 and 1,300 feet. They also are to a large extent wooded.

THE GAP OF LAURAGUAIS. The passage leading from Aquitaine to Bas Languedoc is a double feature—a gap within a gap. The Aude, emerging from the Pyrenees, turns at Carcassonne into a natural trench, some ten miles wide, between the Corbières and the Montagne Noire, and receives the Fresquel from the west. Taking the direction of its tributary, it flows towards the Mediterranean. If we follow the Fresquel through the low plateau of Lauraguais to Castelnaudary, we find that a low *col*, the Col de Naurouze, gives access across the Côteaux de St. Félix, to the valley of the Lhers Mort, which leads down to Villefranche and Toulouse. The natural features here are very similar to those of the gate of Belfort, between the folded Jura and the Vosges, where the trenched valley-way lies within the major gap between the mountains.

Toulouse, once the capital of Languedoc, now the *chef-lieu* of the department of Haute Garonne, with a population of 204,000, has a strong nodal position. Routes converge upon the town from the Pyrenean passes and valleys, from the gate of Carcassonne and from Bordeaux. Northward, via Montauban and Cahors, runs the road to the great junction of Brive, whence routes radiate to Brittany, Paris and the upper Loire. The local position is a strong one. The town spreads on both sides of the river but the old town is situated on the high right bank. It is protected by the steep-edged, tapering end of the Tertiary plateau, which lies between the Garonne and the Canal du Midi on the south. East of the town the low plateau is divided by

steep-edged valleys into north and south strips, thus forming a series of natural fortifications. The canal, sweeping in a curve through the eastern end of the town, is an added protection.

Toulouse is the natural market of the basins of the lower Tarn and Lot, with their heavy production of fruit, and of the basin of the Lhers, with its comb-makers and textile workers ; of the pastoral industries of the Central Pyrenees and of the fruit and wine products of western Languedoc. Its modern importance is due to its railway communications, no less than seven lines converging upon the town. It is thus an important entrepôt



IG. 48. THE GATE OF CARCASSONNE—THE WIDE, STEEP-EDGED PASSAGE BETWEEN THE MONTAGNE NOIRE AND THE CORBIÈRES. THE COL DE NAUROUZE GIVES ACCESS TO THE GARONNE BASIN

etween the Atlantic and the Mediterranean, specializing in wine, cereals, oil, leather, etc., has a very important market for hides and skins and, besides chemical and munitions works, has developed industries dealing with tobacco, timber, flour, and paper. It manufactures also bicycles and boots and shoes. North and south of Toulouse much market-gardening is carried on, the cultivation of the *cornichon*, or gherkin, being a speciality which occupies a large number of people in the fields and in the process of pickling.

To the west of Toulouse lies the country of *Armagnac*. Here road valleys have been trenched, by streams from the Lannezezan in the plateau of morainic waste, in which the fertile tertiary marls and clay are exposed. All the country is arable, but it is very dry. We see long, level fields, capable of being

ploughed by a tractor, where maize and wheat are grown. Large numbers of geese and turkeys feed in the meadows or on the stubble. The vine does not occupy a large area here, but the brandy of Armagnac is nevertheless famous. In the valley-bottoms meadows are irrigated, when there is water in the rivers, and provide pasture and winter fodder for large numbers of cattle. Auch, the local market, lies perched on a bluff above the river Gers. The oldest part of the town lies on a platform overlooking the cathedral, from which a monumental staircase leads down a steep slope to the river. It is typical of the ancient perched fortresses of Aquitaine. To-day the town specializes, apart from the manufacture of brandy, in the making of *pâté de foie gras* and other delicacies that have a world renown. Other small market towns of Armagnac are Mirande and Condom on the Baïse.

As we go northwards of Auch the poorer glacial soils of the ridges disappear. Palms, growing in the gardens of farms and houses, speak for the mildness of the climate. The low limestone plateaux, where the soils are loose and dry, are covered with orchards of peach, plum, and cherry. Cultivation on the lower ground is in long strips, maize, tobacco, wheat, vines, artichokes, potatoes alternating with one another. In the Garonne plain the cultivation of vegetables is carried on—asparagus, beans, tomatoes. With Agen, near the junction of Gers and Garonne, plum cultivation becomes intensive. The marly soil appears to be peculiarly suitable. Vines grow everywhere on the plains and valley slopes, a black variety of grapes being common. Plums are dried and exported in very large quantities as *prunes* and *pruneaux*, but they are suffering from the competition of the larger and more succulent varieties produced in California and Serbia. The same type of country continues north of the Garonne in Guyenne, which is traversed by the Lot and the Dropt. The soils become more definitely limy as one goes north. Here and there the ridges have shallow cappings of harder limestones whose edges form a wall about ten feet high.

BORDEAUX AND ITS HINTERLAND. If we follow the Garonne downstream we find the vine becoming an increasingly important factor in the agricultural system. In Bordelais viticulture has made a wonderful recovery from the phylloxera which devastated the country from 1875 to 1885. Vines are everywhere, on hill slopes and valley-bottoms, and even cover the alluvial river terraces. But on the sandier soils of the Garonne terraces the vineyards are apt to suffer from drought. The whole country is crowded with villages.

Bordeaux is the outlet for this great fertile basin of the Garonne. It is the fourth city of France, with a population in

1936 of 246,378. It stands on the left or west bank of the Garonne twelve miles above the junction with the Dordogne. It is sixty miles from the sea, and the river is tidal, the tide being felt thirty-four miles above the port. Bordeaux has most of the advantages and disadvantages of a river port. In early days the tide was a great advantage in bringing small craft into the land. The position of the port near the head of navigation is of great advantage to it to-day, in that it makes possible a convergence of railway lines, which radiate through Aquitaine and communicate with Paris and the Mediterranean and with Spain. On the other hand, the long passage of the Gironde, with its shifting banks, makes it difficult for large modern vessels to reach port, and Bordeaux has lost a certain amount of trade, especially where the big liners are concerned, to such deep-water ports as Cherbourg and Vigo, Le Havre and La Pallice (the outport of La Rochelle). Although railway communications within the basin of Aquitaine are reasonably good—three lines of the State Railways converging on Bordeaux—the great barrier of the Central Massif, with its extension in the Limousin plateau, has prevented any rapid service of trains to the north-east and east, so that, although Bordeaux is excellently placed for trade with the West Indies, North and South America, and West Africa, it is prevented from becoming the gateway of western Europe as far as these countries are concerned. The North Sea ports, with their shorter and better railway communications, have the advantage. Electrification of the railways that traverse the Central Massif would be a boon to Bordeaux in this respect. Bordeaux is also at a disadvantage from the fact that it has no important waterway system behind it. Both Dordogne and Garonne are irregular and unreliable in their flow and subject to serious floods. The Garonne lateral canal,¹ with a depth of six feet and capable of taking the regulation canal barge, is hindered in the development of its traffic by the inadequate dimensions of the Canal du Midi, which connects it with Narbonne and the Mediterranean ports. There is no communication with the canal network of the Paris basin, and it takes one month to travel from Bordeaux to Narbonne by canal.

Bordeaux in the past had important trade connexions with England. During the 300 years when the duchy of Aquitaine and the kingdom of England were under the same rulers, trade was greatly encouraged, particularly the wine trade, and to-day wine, brandy, pit-props, resin, fruits, and market-garden produce enter the British ports in exchange for coal, sheet-iron, tin, machinery, copper sulphate, etc. With Spain also trade communications are of long standing, minerals and agricultural

¹ Vessels can now pass from Castets on to the lateral canal at any time of the tide.

produce, wool, cork, and olive oil are imported in return for salt cod, superphosphates, and timber (particularly railway sleepers) from the Landes. With the development of the French colonies of tropical Africa came the trade in ground-nuts and palm kernels in exchange for wine and liqueurs, textiles and food-stuffs. Bordeaux is the Bristol of France in its relation to the Antilles, from which it receives cocoa, rum, and sugar. Coffee is imported from Guadeloupe. From the east coast of South America it receives chilled meat in increasing quantities, quebracho extract, and wool, and sends in return wine and brandy, for which South America is a very important market to-day, and manufactured articles of all kinds, particularly those that are styled *de luxe*. Bananas are imported from the Canary Islands and Guinea. The opening of the Panama Canal has helped Bordeaux by bringing it into touch with Chile and Peru, whence it imports nitrates, copper, hides, and skins.

Bordeaux has not developed greatly hitherto as a manufacturing centre, although that side of its activities is increasing, having received considerable stimulus during the 1914-18 War, particularly in the development of a metallurgical industry. Bottles are manufactured for the local wine industry and for export to South America, and cement is made from the lime of St. Astier in Dordogne. Its hinterland is almost purely agricultural, for the coal-fields of Decazeville and Carmaux-Albi (Tarn) are too small for any concentration of industry. The iron-fields too are small and scattered. The manufacture of wine and brandy, the preparation of wool from the skins imported from the Cape, South America, and Australia as at Mazamet, with a small allied textile industry, and leather-dressing as at Graulhet, the preservation of fruits and vegetables—these manufactures do not require great quantities of coal and do not greatly help in the development of bulk cargo traffic. Bordeaux has always been and remains to a large extent, a port dealing in the special product of its hinterland;¹ it is essentially a wine and brandy exporting port. And having become a specialized port it deals also with Spanish and Mediterranean wines, the first being originally introduced to blend with the Bordeaux wines. Some of the Bordelais wines, being relatively poor in alcohol content, were apt to deteriorate in transport. Unfortunately for Bordeaux, the short-sighted opposition of the winemakers of the Gironde to the import of foreign wines led to a decrease in the export of blended wines, and this factor, together with the high luxury taxes in certain countries which had previously been good markets, and prohibition in others, has seriously affected the trade in this special commodity.

¹ Imports in 1938: 2,500,000 metric tons, of which coal 1,000,000, oil 900,000, chemicals 207,000. Exports in 1938: 640,000 metric tons, of which timber 300,000, wine and spirits 49,000.

² André Loisy: *Le Rôle Economique du Port de Bordeaux*, 1919.

Bordeaux has taken full advantage of the traffic in the timber of the Landes, and in the resin and turpentine trade connected with it. The timber, sent to South Wales, supplies a welcome bulk cargo for export to counterbalance the incoming coal and petrol. Much of this timber, however, goes through the outport of Pauillac, in Médoc, and a little is sent out via Bayonne.

Twelve miles below Bordeaux the Dordogne joins the Garonne. The combined rivers are known from the point of confluence as the Gironde. This flows in a north-west direction, following a synclinal depression, and forms a great tidal estuary about fifty miles long. Between Garonne and Dordogne a tongue of land known as Entre-deux-Mers, ending in a long promontory of alluvium, is all under the vine, as is the Médoc peninsula, which lies between the Gironde and the sea. Here, where the estuary is some five miles wide, thirty miles from the open sea, and twenty-four miles below Bordeaux, lie the outports of Pauillac and Trompeloup at a point where the channel swings to the left bank, giving anchorage off the latter place of twenty-four to thirty-two feet. The anchorage here is good in all weathers; but unfortunately the current is apt to be very swift, making communication with the shore difficult. Pauillac is the centre of the Médoc wine industry.

THE LANDES. Stretching from the Pointe de Grave at the mouth of the Gironde to the foot of the Pyrenees near Biarritz is a strip of sand-dunes about seven miles wide. Small streams, rising some thirty miles inland, make their way through the upper Tertiary rocks to within ten miles or so of the sea. Their mouths have been blocked by sand or clay alluvium carried along the coast by the currents that set southward along the shores of the Bay of Biscay.¹ Sand-spits have been built across the creeks and bays by which they once reached the sea, converting them into lagoons, which now lie several miles inland. The landwards shores of the lagoons represent the old shore line. Some lagoons drain direct to the sea, others drain the one into the next, parallel to the coast and behind the dunes, until they find an outlet into the basin of Arcachon. This broad, triangular gulf, into which the river Leyre also drains, has relatively steep shores, and the outflowing river has managed to retain a narrow outlet to the sea, albeit Cap Ferret is steadily extending southward across it.² The little port and bathing and health resort of *Arcachon* lies among the pine woods on an elevated promontory to the east of

¹ Within a mile of the shore the current sets constantly southward with a velocity of half a knot. See *Bay of Biscay Pilot*, Washington, 1926, p. 371.

² Cap Ferret is said to have extended two and three-quarter miles to the south since 1768. See *Bay of Biscay Pilot*, p. 372.

the entrance. The name in the local *patois* means 'resin'.¹ It is a fishing-port of some importance. Oysters are cultivated and there are sardine fisheries in the basin and along the outer coast. There are good anchorages with depths varying from three to six fathoms, but currents are apt to be very strong at the entrance. The coastal dunes rise to heights of 160 to 220 feet. They are planted with pine, which has checked the movement of the dunes inland; nevertheless, movement of the sand continues slowly, and it has been shown that in places the sand has actually buried completely sections of forest.² Behind the dunes a great plain of sand and marsh stretches inland to the Garonne, widening to as much as forty miles in the south. The sand is of recent origin, though older than the dunes, and overlies Tertiary rocks which are exposed in some of the valleys. This sandy plain forms heath and bogland, owing to a hard, impermeable pan that forms at the bottom of the sand. On the plain west of the Garonne the forest is mixed, but the pine forms an important element. It has taken the place of the waste of heath and swamp that provided pasture for sheep and a few cattle and horses. Afforestation and drainage have transformed the one-time unhealthy waste of malarious moor and fen, with its wretched and diseased inhabitants, into a prosperous country. Heather, bracken, and bramble form a ground covering beneath the trees. Avenues of cork oak appear here and there. These trees have a curious appearance, for the bark is stripped for ten feet from the base, that above being covered with grey lichen. Small clearings here and there, protected by wire-netting from the rabbits, produce maize, melons, and vegetables, and milch cattle are being reared in increasing numbers.

The forest is composed of fine, tall trees of a species known as the maritime pine; their needles are six to eight inches long, and they produce very large cones. When the trees are about twenty to thirty years old, and after a systematic selection by thinning has been carried out, small earthenware cups are attached by wires to the trunks below deep slashes that are made in the bark to excite the flow of resin. Long streams of this gum trickle gradually from the wounds into the cups to be collected in the autumn. From the gum essence of turpentine is procured by distillation, and there are a large number of by-products. The residue is used for glue and other purposes. Experiments have been carried out in the distillation of the wood itself. The timber is exported for pit-props, but when injected with sulphate of copper it becomes durable enough for railway sleepers and

¹ The industry of resin-getting only dates back for about a hundred years.

² J. J. Wolff, 'The Dunes of Sabloney near Arcachon,' *G.J.*, May 1929, p. 453.

telegraph poles. The excess of resin makes it useless for pulping, but scientific investigation is proceeding with a view to overcoming this difficulty. The best trees are tapped till they are exhausted. The trees cut in the process of trimming are utilized for pit-props; the larger timber which has been exhausted by tapping is finally felled and the forest growth starts afresh from the seedlings. The maritime pine, then, is a great asset to Aquitaine and the port of Bordeaux.

As one might expect, population is still small in the forest, for the sheep, of which there used to be very large numbers among the marshes of the interior, have greatly diminished in numbers with afforestation, which in itself does not require very many employees, and the cultivated clearings are small. Maize becomes a more important crop in the clearings towards the south, but it does not grow high until the rainy foothills of the Pyrenees are reached. Here and there along the coast, at the exits of the drains from the lagoons, little fishing ports have sprung up, some of which, especially since the coming of the motor-bus and car, are being transformed into watering-places. The utilization of Bordeaux as the American military base during the Great War led to an influx of American visitors for some years after the War, and the building of a large number of hotels. Mont de Marsan and Dax in the south, the one on the Midouze and the other on the Adour, are railway junctions and market centres for the Landes. Dax, as its name implies, has mineral springs.

THE DORDOGNE BASIN. In our chapter on the Central Massif we traced the Dordogne in its journey through the Causses de Martel, into which it trenches a deep, winding valley. There is little change in the type of the valley, as it crosses the Upper Cretaceous rocks into what is known as Périgord Noir. In the neighbourhood of Bergerac, however, it enters a sandy, wooded country of the Lower Tertiary rocks, a country of pine woods and oak coppices with soft, sandy roads, small patches of cultivation surrounding little farms that cultivate vine and beet. The short turf of heath-land provides a limited herbage. Geese and turkeys abound, however, tobacco does well in the mild climate, and sun-flowers are grown for seed. Walnuts, which dislike the limy soils, flourish here. Transport is largely by donkey cart. Below Bergerac the valley of the Dordogne widens, and the river winds sluggishly over a broad plain of alluvium till it reaches the Gironde at Bourg. This portion of its course is in strong contrast to its encased higher valley, with its jutting cliffs, picturesque castles, and rushing water.

At Libourne the waters of the Dronne and Isle converge upon

the Dordogne from the north. These streams cut through the sandy country that we have just described, but they have first traversed a broad belt of Cretaceous limestone, sometimes referred to as 'Périgord Blanc', which is exposed along the anticline already mentioned, which runs from the island of Oléron to the Causses of Quercy. Here we find once more great limestone cliffs overhanging the river plains, sheep grazing on the thin soil of the higher slopes, cultivation of maize, vines, fruit trees, and fodder plants on the lower; irrigated meadow and patches of cultivation on the flood-plain. This country is apt to become very dry in the summer. The streams often dry up completely, but the air always retains that balmy softness so characteristic of Aquitaine. The light soil of the valleys is good for market-garden produce, tomatoes, and red peppers. On the upland the farms are scattered, surrounded each by its orchard, where the plum tree dominates. Prunes are preserved throughout this area. Outliers of Tertiary sandstone are covered with woods, chiefly oak, on whose roots the famous Périgord truffles grow. Périgueux on the Isle is the chief market town. It has grown rapidly in recent years owing to its important railway communications. It lies on the slopes of the plateau in a bend of the river Isle. It was a Gallo-Roman town of some importance. The remains of the amphitheatre and other Roman buildings may still be seen on the low western slopes.

THE CHARENTE BASIN. *Angoumois* is drained by the Charente, which rises just within the crystalline Massif, flows north in the Liassic trough which skirts its edge, through Civray, St. Savin, and Ruffec, and cuts a winding course across the limestone to Angoulême, at the junction of the Jurassic and Cretaceous rocks, where it is joined by the Tourre. The ancient city of *Angoulême* lies on a low bluff of limestone, 240 feet high, which descends steeply to the Charente on the north and to a tributary, the Anguienne, on the south, and had thus a strong defensive position. The city has accommodated itself to the shape of the flat-topped promontory on which it stands, and lacks the regularity of plan of most of the defensive cities of France. The boulevards follow the lines of the ancient ramparts along the brink of the height. From them a wide view of the rolling, fertile country of Angoumois and Périgord can be obtained. The modern town, with its large paper mills, has developed along the Charente on the flat and along the valley road to Périgueux. The railway from Bordeaux to Paris tunnels right under the bluff on which the city stands, and the line from Bergerac is also forced to tunnel through the narrow neck of upland that united the city rock to the main plateau. The main road utilizes this neck to

pass on to the plateau in the direction of Bergerac. Angoulême is one of the few border towns of the Central Massif that have suffered a diminution of population. This is probably owing to its inaccessibility. The warm limestone slopes of the Charente valley are covered with vines, from which, in Tarnac and Cognac on the Charente, brandy of excellent quality is manufactured. Cognac, the centre of the brandy industry, increased its population between 1866 and 1921 from 9,400 to 18,800, but shared the difficulties of the wine trade due to prohibition, taxes on luxuries, post-war depression, and dropped to 15,947 in 1936.

The Charente continues now through a typical *champagne* country where the bare, dry, limestone plateau lies at 150 to 300 feet above sea-level and is for the most part under cereals. Small hamlets are dotted over its surface. In *Saintonge* an outlying patch of Lower Tertiary sands causes a change from the champagne to the *bocage* type of land. At Saintes, the Charente cuts a broad valley in the Upper Cretaceous sandy limestones. Water bursts out in innumerable springs along the foot of the steep valley walls. In flood-time the tidal river covers the valley floor, which during the summer forms good pastures. Saintes is an important railway junction and *dépôt*; two railway lines connect it with the Gironde and another follows the Charente to Rochefort. The railway employees and works occupy an annexe some distance from the old town, which remains the agricultural centre for Saintonge. Further downstream, in the neighbourhood of Taillebourg, there are important stone quarries at St. Savinien which employ a large number of workmen. At high water the river is navigable here for vessels of ten feet draught. The valley becomes more and more marshy and the tidal flats at low water more extensive. At Carillon the river Boutonne has its confluence. It drains a dry and stony country in the Jurassic limestone, where the vine, however, appears to have recovered from the phylloxera disaster, and where brandy is an important article of manufacture. St. Jean d'Angély, an old fortified town with narrow streets, is an important rail and road centre, and has therefore a number of small manufactures, such as chocolates, boots and shoes. The place is also a remount *dépôt* for the army. Tonnay lies at the head of navigation at high water on the Charente for sea-going vessels having a draught up to sixteen feet. It is the commercial annexe of the naval port of Rochefort, which lies ten miles from the mouth of the river, which enters the sea by a deep estuary (twenty feet at low water spring tides) protected by islands at the mouth. Coal, phosphates, and pyrites are among the more important imports of this little port; brandy and

superphosphates are exported. Bordeaux is a more important port for the export of the brandy that is manufactured in the hinterland of Tonnay-Charente and Rochefort than these ports themselves. The estuary of the Charente, although much has been done to improve the channel, winds a great deal and the tide runs out a long way, leaving a great expanse of muddy sand. Moreover, vessels bound for the commercial ports of Rochefort and Charente have to pass through the military port of Rochefort where there are a number of regulations to be observed, and the military port is liable to be closed at any time when naval manœuvres make it necessary. It is unlikely therefore that these ports will develop greatly. The land is building out along the whole of the Biscayan coast, filling up the once drowned valleys with broad marshes which lie between headlands of hard rock.

Rochefort is built on such a rocky eminence standing above the mud flats. This gives it a commanding position. The rectilinear town is still surrounded by ramparts, which limit its development. The main occupation is shipbuilding.

Opposite the estuary of the Charente the Isle of Oléron, sixteen miles long, forms the north-western extremity of the Saintonge anticlinal.¹ Here erosion has laid bare the Jurassic limestone rocks which form an escarpment facing the mainland and overlooking a swampy plain bordered with sand-dunes and submerged at high water. Behind this edge, along the backbone of the island, runs the main road. Along the west coast Cretaceous limestones form a rocky coast, white with breakers in rough weather. The more sheltered east coast has a number of small fishing-ports. In the interior several villages are supported by viticulture. The narrow hog's-back of limestone that represents the eroded top of the anticline is continued to the mainland in a string of rocky islands now surrounded by tidal marsh. On either side of this ridge synclinals are represented by old saltings from which salt used to be extracted. To-day these shores are used for mussel-beds and oyster-parks, and the higher marsh forms valuable grazing-ground. Marennes in the marshes is a centre for oyster culture. The Seudre forms a long estuary in the more southern of these two depressions. A canal from Tonnay-Charente opens into it near Marennes, allowing barges to avoid the passage through the naval² port of Rochefort. The anticlinal of Angoumois brings the Jurassic limestone to the coast at La Rochelle, between the marshes of Poitou and Saintonge, in the Pays of Aunis. Inland the limestone lies at such a low level that water is easily obtainable and villages and hamlets are crowded together. Here, after the phylloxera disaster to the

¹ A useful map will be found on p. 377 of Gignoux's *Géologie Stratigraphique*.

² Now demilitarized.

vines, much of the land was devoted to the cultivation of beet for the distilleries. A more important development was co-operative dairy-farming, chiefly for the production of butter and the rearing of pigs.

LA ROCHELLE-PALLICE. La Rochelle has grown rapidly in modern times owing largely to its deep-water annexe of *La Pallice*. Before the siege of 1628 by Richelieu it was a flourishing town, strongly fortified, the port consisting of a small basin south of the town, now locked and used mainly for vessels which are being dismantled.¹ It held out for fourteen months, owing to the strength of its position. It was re-fortified by Vauban, after the demolition of the fortifications of Richelieu. To-day the old port is hardly used. An outer basin has an area of seven and a half acres, but it only has a depth of three feet on the lock sill. There is also an outer port with a depth of about three feet. Obviously these conditions are quite inadequate for a modern commercial port, but La Rochelle is an important fishing-port.² La Pallice was opened to navigation in 1891. It is situated on the southern corner of the promontory which juts out westward of La Rochelle, about three miles from the latter town. The depth on the sill of the dock is thirteen feet at l.w.s.t. At neap-tides vessels drawing twenty-three feet can enter the dock at almost any time. There is an outer port with a depth of twenty-three feet at l.w.s.t. The port is well provided with railway sidings and other modern equipment. It has become a serious rival to the port of Bordeaux.

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¹ See *Bay of Biscay Pilot*, p. 325.

² Second only to Boulogne in 1937 in value of fish landed, though Lorient landed a greater weight.

CHAPTER VIII

THE FRENCH ALPS

THE French Alps include a great part of the western section of the great folded system of mountains that sweeps from the Gulf of Genoa northwards and eastwards as far as Vienna. It is not possible to do more here than refer very briefly to the history of the building of the Alps.¹

Modern geologists ² lean to the view that the base and foundation of the Alps is a portion of the Hercynian folded system, and that its geological history was very similar to that of the Central Massif, in that it suffered peneplanation, re-elevation, and submergence in post-Carboniferous times, the submergence lasting throughout the Triassic, Jurassic, Cretaceous, and part of the Tertiary periods. A further resemblance to the other ancient blocks of the Hercynian system was the preservation in shallow synclinal folds of Carboniferous rocks. Some of these appear at the surface to-day as a result of intense erosion, but the coal measures have undergone such great metamorphosis that they have unfortunately no economic value.

The upfolds of the present Alpine system did not emerge from the great marine depression in which their rocks were deposited until mid-Tertiary times, but it is likely that there were more or less continuous earth movements in the ancient Hercynian rump, in sympathy with the ancient directions of folding. It was after the raising of the Pyrenean folds, which were continued through Provence, that the eastern Alps were folded up and forced outwards against the resistant Hercynian masses to the north. Subsequently, at the beginning of the Miocene period and after a period of rest, tectonic movements began again in the Alpine region. The earliest folds were formed in the north, on the flanks of the resistant Hercynian blocks (upper layers of the archæan floor being included in the folding), and their subsequent folds from the south were forced against them, overriding them and tearing them from their sockets. This tremendous horizontal movement resulted in great masses of land (*nappes de charriage*) being transported as much as thirty miles from their base and piled up to form great mountain masses. The foundations from which they originated lie to-day hidden beneath the plains of Piedmont and Lombardy.

¹ A simple and clear account of the origin and structure of the Alps will be found in *The Physiographical Evolution of Britain*, by L. J. Wills, Chap. XVI.

² L. de Launay, *op. cit.*, p. 387.

The synclinal depression which was formed between the Alpine folds and the edge of the Block Mountains was filled, as the Alps rose and erosion became more and more intense, with immense thicknesses of detritus. These sediments, to a certain extent, were included in the subsequent folding.

Erosion of these complicated, recumbent folds, overlapping and overriding one another, has produced a mountain system of the utmost complication. The work of erosion has, of course been profoundly affected by glacial action.

The Alps may be divided into three sections:¹ Western, Central, and Eastern. In the Eastern Alps the mountains form long, parallel ridges, running from west to east. In the Central Alps the characteristic feature is the division of the uplands into huge irregular blocks; in the west long ranges are again characteristic features, separated from one another by long, parallel valleys. The general trend of the mountains in the west is at first north-east to south-west, then north to south, and then, apparently under the influence of the Pyrenean folding, from west to east. The Eastern Alps have a narrow central zone of crystalline rocks, flanked by broad zones of limestone mountain. In the Central Alps the limestone zones are less dominant and the crystalline zone is broad and massive. In the Western Alps the limestone zone of the inner curve is missing, but the outer limestone belt is very wide. The crystalline zone in the Western Alps is divided into two belts by a rugged zone of Permian and Carboniferous rocks, which is known as the Briançonnais zone. The western or outer crystalline belt is called the Mont Blanc zone, and the inner or eastern belt the Monte Rosa zone.

The Western Alps south of Lake Geneva lie, for the greater part, within French territory. The Franco-Swiss boundary follows the water-parting between the Lower Valais (Rhône valley) and the Drance, which also drains to the lake of Geneva, then skirts the head of the Arve valley and the vale of Chamonix to pass to the Massif of Mont Blanc. Thence the Franco-Italian frontier follows the water-parting formed by the steep eastern edge of the Massif, and continues along the main crest of the crystalline Alps, keeping to the divide between Rhône and Po drainage, and then following the ridge of the Maritime Alps to reach the sea east of Monaco.

THE CRYSTALLINE ZONE OF THE HIGH ALPS. In the north, the French Alps consist mainly of crystalline rocks, and include the Mont Blanc Massif with the Aiguilles Rouges, followed

¹ The author, as a geographer, has preferred this threefold division based on surface features, to the classic division into Eastern and Western Alps of the geologists.

southward by the long ridge known as the Belledonne chain, the Grandes Rousses, the Taillefer, and the Mont Pelvoux—mainly composed of mica-schist and gneiss.¹ South of the Pelvoux Massif the sedimentary zone of the Briançonnais curves westward and crosses the frontier into the French department of Hautes Alpes. Here it forms a varied and much-accidented region, owing to the differential erosion of the rocks exposed. Certain ancient limestones stand up as peaks and ridges, while softer rocks, clays, and gypsums have been worn down to form broad valleys, as in the upper basin of the Durance in the region known as Briançonnais, from the town of Briançon, and in the Embrunois farther south. The crystalline and Briançonnais zones are included in the High Alps; their peaks rise to 10,000 and 13,000 feet.

THE LIMESTONE HIGHLANDS. West of the crystalline zone lies an outer belt of limestone uplands, which include the pre-Alpine Chablais mass, the sub-Alpine plateaux of Genevois, Bauges, Chartreuse, Vercors, Diois and Ventoux, the Maritime Alps and the Basses Alpes. Between the middle Rhône and Isère the belt is narrow. South of the Isère it widens and thrusts out long spurs towards the Rhône between the valleys of the Drôme, Roubion, Lez, and Aygues. The general trend of the Alpine folds follows the curve of the Alps, but towards the south, beginning in the south of the department of Drôme, the earlier Pyrenean folding complicates the north to south system, with the result that cross-graining exists. Still farther south the west to east trend dominates. At the same time the Jurassic limestone, which forms the main mass of the French Alps in the north, becomes less important and forms only the crests and cappings of ridges formed of marl and clay. These ridges decrease in height towards the south.

THE SUB-ALPINE DEPRESSION. Between the crystalline and Jurassic limestone zones of the French Alps a long and continuous trench, which we may call the sub-Alpine depression, is occupied in turns by Lake Bourget, the Isère between Chambéry and Grenoble, the north to south section of the Drac, and the north to south section of the Durance. At Chambéry the trench forks, sending an arm north-eastward along the northern edge of the Mont Blanc Massif. The sub-Alpine depression is due to the exposure of a belt of soft Lias shales. It is deepest and most marked in the department of Isère, where the river has eroded in the soft clays the vale of Grésivaudan. In the Drac basin, farther south, the floor of the trench is at a higher level, and forms

¹ These crystalline massifs, often referred to as Hercynian, may be regarded as the exposed cores of local folds, sometimes fractured and displaced by over-riding folds, and now, as a result of tremendous erosion, emerging like islands from beneath the waves of sedimentary deposits that once overwhelmed them.

the plateau of Malesine. The Lias vale forms an important longitudinal line of communication within the Alps, and is followed through most of its length by railways.

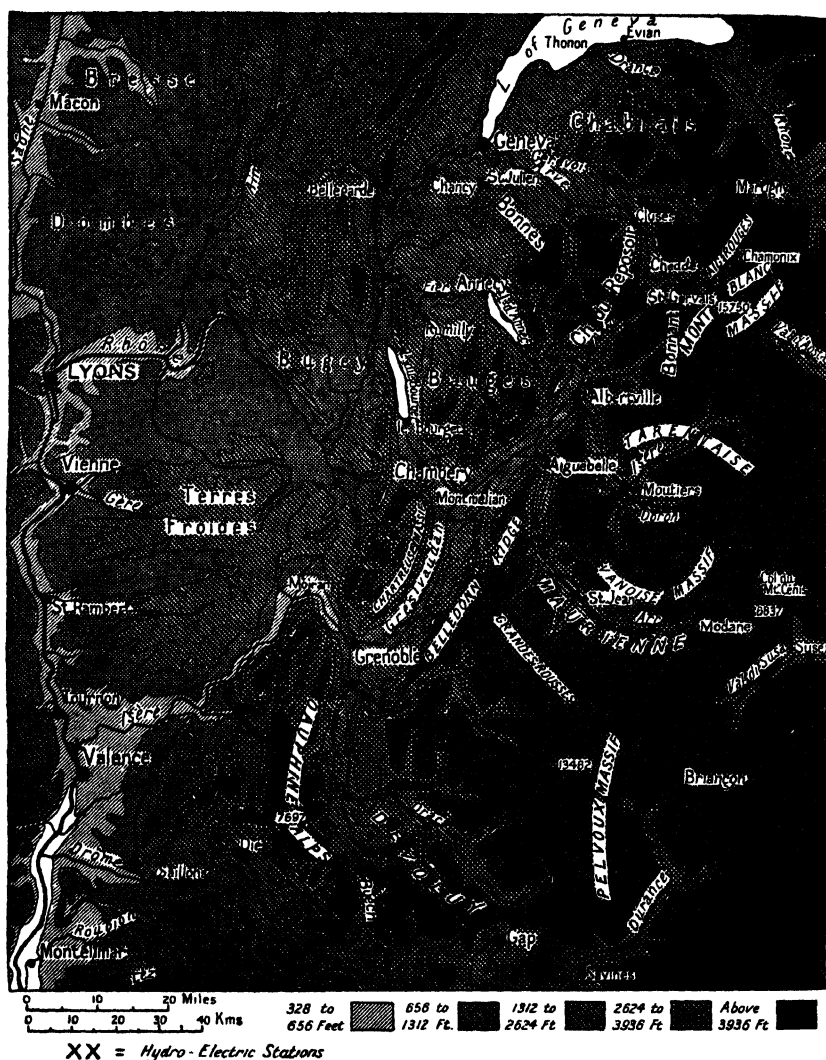


FIG. 50. THE FRENCH ALPS AND THE BASIN OF THE MIDDLE RHÔNE

From the neighbourhood of Le Bourget, in the angle between the Jura and the Alps, the Lias vale, which extends with but slight interruptions from the neighbourhood of Martigny on the

upper Rhône to Montmélian on the Isère, detaches a section of the Alps from the main mass. This section, which is enclosed to the north by the lake of Geneva, to the south and west by the Arve and the Lias vale, is a belt of soft rocks of Cretaceous and Tertiary age consisting of shales, marls, and sandstone, probably derived from the detritus washed down from the central Alpine zone and folded during late Alpine movements. The region is very complicated structurally, for there has been great overthrusting, especially in the north-east of the pre-Alpine limestone and even of rocks from the Briançonnais zone. The district is known as the *Chablais*, and here begins the Chablais zone of Flysch deposits, which continues eastward to form the outermost zone of the Alps along their entire exterior front.

Finally, outside the Chablais zone, a series of low plateaux and plains between the folded mountains and the lake of Geneva and the Rhône comprises the fourth element in the French Alps.

From the geographer's point of view, probably the most noteworthy features of the Alps in France are the enormous development of the limestone zone, the broad, deep, transverse and longitudinal valleys which penetrate far into the eastern crystalline zone, the immature, torrential nature of the rivers and the enormous amount of rock waste brought down by them actually and in the past. All these features are of economic importance.

THE ARVE. We will now examine this region in more detail, beginning at the north. The *Mont Blanc Massif*, most of which lies within France, is a great crescent-shaped block, composed of granites and crystalline schists, some twenty-five miles long by nine miles wide. The bulk of it stands at over 3,000 feet above sea-level, and the Mont Blanc itself, at the southern extremity, has an elevation of 15,770 feet. Except the northern extremity, which drains direct to the Rhône, practically all the voluminous¹ waters of Mont Blanc Massif drain to the Arve, whose valley, carved in the Jurassic slates and shales by water and ice, forms a broad, deep trench separating the Mont Blanc Massif proper from the lower crystalline block of the Aiguilles Rouges, which lies to the north-west of it. This is the vale of Chamonix, with its level floor about 3,300 feet above the sea, covered with irrigated meadows, its steep south-eastern slopes dark with pine, and larch, its leaping cascades and glacial torrents. The little town lies on the valley floor at an elevation of 3,370 feet. It has a score of hotels, a casino, a stadium, a bob-sleigh run, and the other requisites for a summer and winter vacation resort. Small hotels and

¹ The precipitation, owing to exposure of the Massif to the west, is very heavy, and the torrents bring down great quantities of water.

pensions exist in plenty in the little villages and hamlets up and down the valley, which may be considered as an annexe of tourist Switzerland. The rocky slopes rise abruptly from the floor of the valley, but behind the abrupt rise from the U-shaped vale appear the snowy peaks of the Aiguilles and the great glacier-scored mass of Mont Blanc.¹ Half a dozen great glaciers descend almost to the valley floor. Their ancient moraines have blocked the great vale midway, dividing it into an upper and a lower basin. The river cuts its way through this obstruction in the Tines gorge. Seven miles below Chamonix the Arve valley bends abruptly to the north-west to cross the ridge of the Aiguilles and enter the broad valley where St. Gervais-les-Bains stands on a terrace overlooking the plain of Sallanche, near the junction of the Bonnant from the south. Thereafter it cuts through a series of ridges of the folded limestones of the pre-Alps, which, in the eastern Chablais, are thrust over the sands and clays of the Flysch and extend to the shores of Lake Geneva. The Mont Blanc glaciers supply two groups of six hydro-electric power stations above St. Gervais-les-Bains: one on the Arve at Chedde and one on the Bonnant at Bionnay. They serve a number of factories, among which is the important aluminium, carbide, and chlorate electrolytic works at Chedde. The time-honoured industries of spinning, butter-making, wood-sawing, and watch-making, carried on in a string of small factories along the Arve and its tributaries, can now be served with electric power, and new industries have been developed, such as electro-metallurgy, the production of calcium carbide, and silk weaving. The stations can generate 5,000 to 20,000 h.p. In the little basin of Sallanche, 1,600 feet below St. Gervais, the Arve enters the Chablais plateau, which slopes gently towards Lake Geneva and the Rhône from a level of some 6,500 feet. The main rivers trench deeply into the Jurassic limestone. Their tributaries frequently make their entry into the main valley by cascades falling from the abrupt ends of hanging valleys.

At Cluses the Arve emerges from a limestone gorge, by which it traverses the *Chaîne du Reposoir*, into a wide valley which opens a few miles farther down into a broad, marshy plain in the much-dissected and well-watered plateau of Bornes. Here the Flysch zone is represented by friable sandstones and argillaceous sands, which give soils of but little value for agriculture. Cluses, commanding the entrance to the gorge through which pass road and railway, is a centre of the clock-making industry and has a school

¹ Both the Aiguilles Rouges and the Mont Blanc Massif in the Chamonix region are composed of granite, which gives more rugged features than the crystalline schists which hide the granite on the southern slopes of Mont Blanc.

of clock-making. Finally, after crossing the low ridge of the Salève in a gorge, the Arve emerges on to the plain of Geneva. West of Evian the limestone mountains sheer away from the shore-line towards the south-west, forming a steep edge in Les Voirons, which overlooks the broken, hilly country covered with sandy and pebbly glacial deposits stretching to the shore of the lake. This hill country is watered by numerous streams which spring from the limestone edge.

Thus the Arve and its tributaries traverse the Western Crystalline Zone, the Pre-Alpine Limestone Zone, and the Chablais Zone of varied rocks.

The Crystalline zone is too bleak and too poor in soil to offer much scope for agriculture—even the Alpine pasture is poor; but the limestone and Flysch belts have rich alps, and the Chablais region has given its name to a famous race of milch cattle which is found now in many parts of France. The seasonal migration of the herds from the valleys to the limestone Alps takes place at the end of May, when the whole of the farmer's family accompanies the cattle to the châlet in the mountains where the butter and cheese are made. The loams in the limestone valleys of Chablais are fertile, but the sandy plains are markedly less so, and are mainly devoted to dairy-farming and woodland. On the Chablais plateau population is also sparse, owing to the poor agricultural conditions. In the Geneva plain, where communications are better, villages are larger and much more numerous, but are strung out along the main road at the foot of the Chablais scarp and along the coast road. Evian and Thonon are spas, and Evian has developed an important industry in bottling and exporting mineral waters which are known all over Europe. Between these two towns, the Drance, which has cut deep gorges across the limestone ridges, approaches the lake through a broad deltaic plain, which it is rapidly extending. Thonon, like Evian, is built in an amphitheatre against the hillside, and has a funicular railway to the lake shore. Near Douvaine, the French shore comes to an end and the frontier runs inland north of Anne-Masse and St. Julien, to the Rhône at Chancy. It follows the river for six miles, and then doubles back to follow the north side of the lake some three or four miles from the shore. So that, by the lake of Geneva, Switzerland drives a salient into French territory, and the exit of the Rhône and the junction of that river with the Arve lie in Swiss territory.

THE RHONE. West of the Arve the limestone block of Chablais is continued in the Borne plateau and the plateau of Genevois. Between the lake and Bellegarde the Rhône takes a circuitous

course to the west, cutting, like the Arve, through the low southwestern extremity of the Jura folds. The plateaux of Bornes and Genevois drain south to the Fier, which also drains the lake of Annecy on the edge of the Genevois Massif. The Genevois is densely forested except on the lower valley slopes (in which it forms a contrast to the plateau of Bornes), and nowhere rises much above 6,500 feet. The lake of Annecy, which occupies a deep trench separating the two plateaux, is some nine miles long and between two and three miles wide. The town lies on the Fier, at the exit from the lake. It has developed metal foundries, and a tool-making industry. About a mile below the town the waters of the Fier provide power for aluminium smelting furnaces with rolling mills and foundries.

Annecy lies at the junction of the pre-Alps and the plain of Rumilly, where the ground does not rise much more than 600 feet above the lake of Geneva. The plain is more densely peopled than the Genevois plateau or the Bornes, but the population is scattered in small villages and hamlets. Rumilly, on the Chéran, a little above its junction with the Fier, has silk works and supplies firms at Lyons. Just before its junction with the Rhône the Fier cuts in a gorge across one of the minor ridges of the Jura which rises to over 3,300 feet.

Between Chancy, on the Swiss frontier, and the junction of the Fier there are three hydro-electric power stations and a number of factories. This is made possible by the torrential nature of the Rhône as it crosses the southern ridges of the Jura and a fault which crosses the river-bed, causing a drop of about 210 feet, and the supply of power is made regular by the great reservoir of the lake of Geneva above. It is believed by engineering experts that a much greater use might be made of the steep gradient of the Rhône than is done at present.

THE ISÈRE. South of the plain of Rumilly, a great trench, a deepened glacial valley ten miles long and 330 feet deep, connects the Rhône valley with the Isère. The central part of it is occupied by the lake of Bourget; north of the lake the trench is marshy and unpopulated, but to the south it forms a strip of dense settlement between its mountain walls. Here, a few miles south of the lake, lies Chambéry on the little river Leysse. It was the old capital of Savoy. The Roman strong point was on the spur of the limestone ridge to the north. The ducal palace lay on the lower slopes south of the gap, through which the town now spreads east and west.

The course of the Isère imitates closely that of the middle Rhône. It rises, as does its chief tributary the Arc, high in the Graian Alps, whose great snow-covered crescent encloses

the upper Isère basin, and forms the Franco-Italian frontier. The Col du Fréjus, the Col du Mont Cenis, and the Col du Petit St. Bernard lead across the frontier. The Col du Fréjus carries no road to-day, but the railway from Chambéry to Turin, known as the Mont Cenis route, tunnels beneath it. The Col du Mont Cenis links the Arc valley by a difficult but beautiful road, with Susa in the Dora Riparia. The Little St. Bernard road rises in a dozen astounding hairpin bends 3,300 feet to the col at 7,176 feet, and then winds down a rather more gentle slope to Morgex in the Val d'Aosta. The valleys of the Isère and the Arc communicate near their head-waters by the Col de l'Iseran, which, however, carries no road.

The two rivers Isère and Arc now traverse a belt of sedimentary rocks¹—soft slates and shales and hard limestones—which form the upstanding Massif of the *Vanoise* and the broad, deep, glaciated valleys, known respectively as the *Tarentaise* and the *Maurienne*.

The perpetual snow level lies at about 8,850 feet, relatively high because of the low precipitation in the trenched valleys. Below this, down to 7,200 feet, the rocks are bare or covered with small *alpages*. Then the spruce forests begin with alps on the gentler slopes till, at about 5,200 feet the beech and birch begin to mingle with the conifers, and here and there patches of cultivation appear among the rich pastures of the valley. The life of the people is mainly in the valleys and the population is grouped chiefly in communes of more than 2,000 inhabitants, and often in small towns. Potatoes and cheese form the staple articles of diet in these valleys. Cultivation does not suffice for local needs, for the main industry of these high valleys is pastoral. Glacial streams are tapped high up the valleys and led down to irrigate the meadows that supply winter fodder. Most of the cattle are milking herds, of the Tarine race, a sturdy type, economical to feed and capable of standing the fatigue of their long seasonal migration. The high pastures belong generally to an owner who hires the cattle from the farmers of the vale for the summer months and makes what he can from the milk they provide, while the farmer returns to his cultivation in the valley until the winter, when he resumes proprietorship of his cows and occupies the winter months with butter and cheese-making. The *fruitière* system is found here, as in the Jura and upper Savoy,² but less strongly developed. Flocks of sheep are sometimes sent up during the dry summer months by rail from the Rhône delta to the Alpine valleys, whence they are driven up to the high pastures.

The river plains are narrowed from time to time by obstructions

¹ The Briançonnais zone, see p. 245.

² See p. 272

of glacial origin, and drop by steps from level to level, thus providing hydraulic power as the rivers pass from one basin to the next. At Moutiers, a small town in the Tarentaise with about 2,500 inhabitants, the Isère makes a sharp elbow and turns north. Here, on a small river, the Doron, from the glacier of the Grande Motte, about 120,000 h.p. is generated near Boze. In this valley are mineral-water springs and spas at Bride-les-Bains and Salins.

At this point the river quits the sedimentary Briançonnais zone and enters the western forested crystalline Alps, the Chaîne de Belledonne, which it trenches in a deep valley followed with difficulty by national road and railway.

At Albertville the Isère, having emerged from the Belledonne range, enters the sub-Alpine trench of the Lias, and, receiving the Arly from the north-east, follows the trench in a south-westerly direction. Half a dozen miles above the confluence, at the exit from the gorge of Arly, stands Ugines with its great thirteenth-century fortress. Here, supplied with power from neighbouring torrents, there are important electro-metallurgical works which specialize in alloys of rare metals. Another power station is situated lower down at Venthon, just above Albertville. Below Albertville the Isère is canalized; it flows through a broad, flat-bottomed valley a couple of miles wide or more, into which a vast number of mountain streams pour their waters in torrents when the snow melts in the spring, to water the meadows and patches of cultivation, and to supply the strings of villages closely aligned along the lower slopes of the valley. This Lias trench forms a great corridor from Ugines to Montmélian, carrying roads and railway, at a level of less than 1,600 feet—a line of intensive cultivation and busy industry in the heart of the Alps. Half-way along the trench the Arc enters, contributing traffic by national road and rail from St. Jean de Maurienne and the district of the electric metallurgical industry based on the water-power of the Arc above Aiguebelle. At Montmélian, Lake Bourget, trenching through the pre-Alps, joins the Lias trench of the Isère. Half-way between the lake and the Isère lies *Chambéry* at a level of 890 feet only, and with a population of 24,965. This town was at one time the capital of the Duchy of Savoy, owing to its nodal position and to the local fertility of the broad vale in which it lies. The relatively dry slopes are peculiarly suited to vine and fruit culture for export to Lyons, Grenoble, and Paris, and it is conveniently placed close to the junction of high alp and low alp, and therefore forms a frequented marketing centre. Here there are a number of silk manufactures based on hydro-electric energy and related to Lyons.

The Arc, as we have seen, rises only a few miles from the

Isère, but trends south-westward some score of miles from its source ; at Lanslebourg a very steep road climbs 2,200 feet over a distance of three miles as the crow flies, through the Col du Mont Cenis which leads to Susa in the Dora Riparia. The valley of the Arc forms a great bow round the Massif de la Vanoise. Its deeply-cleft valley is supplied with power from innumerable cascades, and hums with industry from one end to the other. Among the products due to the development of ' White Coal ' at Calypso and Plan-d'Arc, at la Praz and St. Michel de Maurienne is electrolytic aluminium. The bauxite comes from the Brignoles district in the department of Var, and the alumina to be worked up is sent from Gardanne.

Below Montmélian, and the junction of the Chambéry vale, the Isère pursues its course between the forested Chartreuse Massif and the snow-covered crystalline ridge of the Belledonne to Grenoble. This section of the sub-Alpine depression is called the Grésivaudan. Here the floor of the valley is less than 650 feet above sea-level, while the mountains on either hand rise to between 5,000 and 6,500 feet. The valley produces cereals, grapes, and fruit ; the mulberry on the lower slopes promotes the silk industry, the chestnuts of the middle slope form a local food and are also exported with the other products as far as Paris. But agriculture, as elsewhere in France, is giving place to industry, owing to hydro-electric developments, and to the development of dairy-farming with the increased demands of the towns. In the high Alps the hardy Tarentaise cattle flourish, but in the pre-Alps the limestone slopes are cropped by the famous milking race of Villard de Lans. Seasonal migration of the cattle is the rule, as in Chablais. They are driven up from their stables in the valleys, first to the foothills or *mont-agnettes*, where their grazing is associated with mixed agriculture, the same farmer owning both upland and lowland farms, and in July, when the snow has disappeared from the high Alps, they are sent up to these pastures for which they pay by the milk they produce, while their owner pursues his cultivation in the valleys and provides, usually under irrigation, winter fodder for the beasts when they return in the autumn. The co-operative *fruitières* play an important part here in the winter, in the making of butter and cheese, where the separators and churns are frequently driven by hydro-electric power. A modern development in the pastoral life is the transference by rail of sheep from the Rhône delta during the dry season into the high Alps, especially to the Belledonne.¹ Pig and poultry rearing accompany the dairying ; the produce is collected in the Isère valley for distribution to local industrial

¹ See p. 402.

centres, or for transmission to the larger centres of Grenoble, Lyons, and Marseilles. Paper-making has developed into an important industry in Grésivaudan, particularly at Lancey, some ten miles above Grenoble, where hydro-electric power is generated on the spot for the various processes, and between 800 and 900 persons are employed.

Grenoble is situated near the southern extremity of the trough of Grésivaudan, opposite the gap cut by the Isère between the Cretaceous rocks of the Grande Chartreuse and the Vercors. It thus commands all the major transmontane and intermontane routes of the Alps—northwards via the Grésivaudan to Chambéry and thence beside the Lac de Bourget and the upper Rhône to Geneva; eastwards, via the Grésivaudan, the Arc valley to Modane, and thence by the Col de Fréjus or the Mont Cenis tunnel to the Dora Riparia and Turin; southwards in the extension of the Liassic trough via the Drac-Ebron valleys to the Buech valley in the upper Durance basin, whence, via Gap, there is communication with Embrunois and Briançonnais, or into Provence by the lower Durance.

This position in the main Alpine corridor ensured the town a rank of importance in Roman times under the title of Gratianopolis. It became in the Middle Ages the centre of the county of Grésivaudan and later the capital of Dauphiné. To-day it is the *chef-lieu* of the department of Isère. It had a population of 90,133 in 1936. Next to Chambéry, it is the most important railway centre of the Alps. The town lies on the left bank of the Isère, in the angle formed at the confluence of Isère and Drac. The old Gaulish city, Cularo, as one would expect, was perched on the bluff which overhangs the right bank. The town is very heavily fortified, the steep sides of the Chartreuse Massif overlooking the plain being utilized for gun-emplacements. Grenoble is the chief centre of glove-making in France. The raw material is derived largely from the upland pasture-lands of the Alps, lamb-skins chiefly being used. Skins are also imported from the Causses and from Aquitaine. About 15,000 women are employed in this skilled occupation. Large quantities of egg yolk are imported via Marseilles from the East for the preparation of the skins. The making of cement is an old-established industry of Grenoble. The limestone is mined in the Grande Chartreuse and is lowered by aerial railway to the works. About a quarter of the cement produced in France is manufactured in Dauphiné. The whole of Grésivaudan has become industrialized without losing its rural characteristics. This has been made possible by the utilization of hydro-electric power. There are many villages engaged in the glove industry, subsidiary to Grenoble, and machinery factories

which provide machines for the gloves, silk, and electrical industries and tyre works ; and there are works making aluminium, electric steel, and ferro-alloys. Grenoble has made a great effort to take advantage of its nodality, its excellent road and rail communications, and the beautiful Alpine scenery, to develop its tourist resources, and in this has to a great extent succeeded.

Below Grenoble the sub-Alpine vale turns due south, but the Isère turns north-west to cross the limestone zone between the Massifs of the Chartreuse and of Vercors, where the valleys have cut down through the Cretaceous limestone into the Gault Clay. At Moirans it emerges from the pre-Alpine zone, turns south-west again into the hill country of lower Dauphiné, where levels vary from 450 to 2,600 feet. The hills are chiefly composed of glacial clays and gravels, giving an infertile soil, which is used for plantations of oak, sweet chestnut, and walnut. As this hill country drops towards the Rhône much of it is devoted to a rank pasture. Bare, flat-topped limestone ridges rise above this glacial material. Great stretches of river gravels share the lower levels with the alluvial plains. They were once well wooded. The regions of the alluvial plains which follow the Rhône from Vienne to Saint-Rambert are the sole naturally fertile regions, but the proximity of Lyons and the provision of hydro-electric power from the mountains have resulted in the spread of industrial population up the lower valleys and a development of cultivation to supply their needs. Villages are ranged along the edge of the alluvial plain on the smaller watercourses. Romans and Bourg de Péage (together nearly 23,000 inhabitants), on either side of the Isère where the broad alluvial plain of the river widens to the Rhône, form a busy industrial centre whose most important activity is boot- and shoe-making. Bourg commands the bridge. Some of the old fortifications still stand. There are no less than 357 silk-weaving establishments in the department of Isère. This is due to the penetration of the industry into the smallest villages for the sake of labour, so we find a reversal of the usual process of suppressing small establishments and concentrating workers in large factories. This curious development has been made possible by the provision of electric power.

South of Grenoble the sub-Alpine Lias vale turns southward and is drained by the Drac. This river derives its sources from Mont Pelvoux and soon finds its way into the sub-Alpine vale which here lies at 6,500 to 10,000 feet, and is known as the Malesine plateau. The streams that drain from the south-west glaciers of the Pelvoux provide hydro-electric power, as at Saint-Firmin and in the neighbourhood of Lamure and Avignonnet. Near the

last two centres deposits of anthracite are mined, where the production exceeds a quarter of a million tons a year.

THE DURANCE. The southernmost section of the French Alps is drained by the Durance, which takes its rise in the central sedimentary, or *Briançonnais* zone. This densely-folded, much-dissected region is traversed by the Durance from north to south in a deeply trenched valley. Tributaries cutting eastward are in communication with the Italian valleys, especially the Dora Riparia, by the Mont Genève, and the Col de la Traversette. Briançon lies two or three miles from the head-waters of the Durance at the confluence of a stream from the Mont Pelvoux. Upon the town converge roads from the Dora Riparia, from Pinerolo, from the Col du Lautaret, which leads across the Pelvoux to the Maurienne, to say nothing of a number of less important transmontane tracks. The town has a population of 3,590 inhabitants and lies 350 feet above the valley floor on a block of hard Calcareous conglomerate. These sheltered basins, particularly *Embrunois*, are so warm that south European fruits such as the almond and apricot, as well as plums, can be grown for export. The valley-bottoms are devoted to irrigated hay meadow, important for the winter feeding of the sheep, which here, as in the more northern valleys, move to the Alpine pastures in the summer and serve to manure the meagre upland farms. Their milk provides the green cheese of the Rocquefort type which is produced locally. The sheep are increasingly reared for meat.

East of Briançonnais rises the snow-clad crystalline mass of the *Pelvoux* to between three and four thousand feet above sea-level. The Durance sweeps round its southern flanks in a series of steep-sided limestone gorges, alternating with flat-bottomed basins. At Savines, where there are a couple of hydro-electric factories, a deep natural trench, drained westward by the Petit Buech, leads west across the high Alps, and is followed by main road and rail, to the sub-Alpine depression, which here separates the high Alps from the fore-Alps of the Devoluy and Gapençais, and continues south to the Durance.

Gap, the Roman Vapingum, stands at the junction of natural cross-roads from Grenoble to Sisteron and from Briançon to the Drôme valley via the Col de Cabre. The sheltered vale of Gapençais, like *Embrunois*, is fertile and dry relatively to the rainswept slopes of the Alps, and the lower valley sides are covered with vineyards, orchards, and walnut trees. The Durance only joins the sub-Alpine vale some twenty miles south of Gap, having first to pass through a narrow defile. Sisteron, in the vale at the entrance to the defile, was once an important fortress guarding the passage from Dauphiné to Provence. The

remains of the ancient fortress that once guarded the route from Dauphiné into Provence stand on the right bank of the river, high above the gorge, the Gap road, and the bridge. In 1936 the population was only 2,559.

At Sisteron the Buech comes in. The two head-waters Buech and Petit Buech rise in the relatively low *Dauphiné Alps*. The scenery here differs somewhat from the accidented country of Briançonnais, with its pinnacles and crags, its terrific gorges, fierce, muddy torrents, and basins of soft shales. The *pre-Alps* are composed of hard, impermeable limestone overlying soft, impermeable marls, so that the rivers cut deep valleys with gentle slopes, surmounted by a palisade-like cliff of limestone. Such cultivation as these high, dry plateaux offered gave way to the extended demand for sheep pasture for the flocks migrating seasonally from Provence. There is no chestnut forest here; on account of the limy soil the plantations consist mainly of conifers. Sisteron stands at the gateway of Provence. Even in Briançonnais and in the Gap valley Mediterranean influences are felt. The railway from Grenoble follows the Buech and joins the Durance valley at Sisteron, twenty miles below which it forks, one branch passing to Marseilles and the other to Nice. The Durance follows the sub-Alpine trench south-eastward and south via Ventavon and La Brillane, both of which have hydro-electric stations and provide between them 84,000 h.p. We are now in the Midi.

THE DROME. Between the Isère and the Durance the Rhône tributaries do not cut back into the high Alps, but drain the pre-Alps. Of these the Drôme and Roubion belong to the Western Alps, the Lex, Aygues, and Ouvèze drain the Maritime Alps and belong to Provence.

The Drôme rises just to the west of the sub-Alpine trench and flows north-west between the Montagne, represented by the rugged limestone and sandstone ridges of the Devoluy and the more dissected hills of Cretaceous rocks to the west. Here the north and south folding that characterizes the Western Alps in France is less marked and begins to give place to the Pyrenean east to west folds of the southern Alps.¹ Here again the Cretaceous marls and clays are worn into wide valleys, but the summits of the ridges are capped with thin layers of limestone, which gives the characteristic palisade-like brink surmounting the gentle slopes, a type of scenery which becomes more and more marked as we near the Mediterranean. In the upper Drôme valley the population is sparse and congregated in villages, owing to the scarcity of water. Die, with a population of 3,300,

¹ See p. 245.

commands the difficult route north to Grenoble. It lies at the lower end of a basin some nine miles long. The little town has interesting Roman remains. At Saillons the river leaves the Oolitic limestone and enters the softer Cretaceous rocks, where the sandstone hills are well wooded and paper-making becomes an occupation of some importance.

The Drôme basin marks a transition zone between the northern and southern French Alps. In the north, the sub-Alps are a minor feature, forming a comparatively narrow strip. In the south they widen till they become the major feature of the system. In the north their folding is comparatively simple, and long ridges and valleys are found. In the south the folds are short and the direction is no longer uniform, the Pyrenean trend becoming more and more marked towards the south. Moreover, the constituents of the rocks show a greater variety and the whole country is therefore more accidented as the result of weathering. Where the rivers have excavated to the Liassic black marls, open basins are formed; where limestone Massifs occur the rivers cut narrow gorges.

The climatic differences are important too, although the change over from the central European to the Mediterranean conditions is more gradual, owing partly to elevation. (See p. 21.)

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THE RHÔNE-SAÔNE CORRIDOR

THE Rhône-Saône corridor is the counterpart in the east and south-east of the Central Massif. It consists of a depression, continuous, if considered as a broad feature, lying along the fractured edges of the Vosges, the Monts Faucilles, the Plateau de Langres, the edge of the Morvan, and the Eastern Massif, and curving south-eastwards along the Cévennes in Languedoc.

The morphology of its western wall involves consideration of structures that take us back to Carboniferous times, particularly the great Hercynian folds whose worn-down and re-elevated masses still exhibit the Hercynian trends. These, reflected to-day in lines of easy erosion and the preservation of coal and other sedimentary deposits, have important effects on present-day settlement, communications, and industry. The eastern boundaries of the depression are much less definite, but, broadly speaking, they are formed by the limestone uplands of the Alps and Jura. Hercynian folds, masked by Jurassic deposits, form the foundation of the successive sills which link one Massif with another, and make possible, albeit not easy, communication between the Saône-Rhône depression and neighbouring basins. These folds may also be detected in the low ridges which traverse the depression itself, for, when examined in detail, the corridor proves to be formed of a series of depressions, structurally more or less resembling one another, but geographically forming separate entities. It was only with the development of engineering science that the Rhône-Saône-Rhine 'corridor' became an actual fact. In days of early settlement the routes crossing the corridor were as important as those following it from end to end.

Once again we have to draw attention to the important part played by deep-seated rock structure in determining surface conditions of human environment.

Although the presence of a depression in the neighbourhood of the Rhône-Saône valley (the Fosse Voncontienne) goes back to very early geological times, it is only between the confluence of Isère and Eygues that its emplacement corresponds with the present Rhône depression. After the Hercynian folding, portions of the trench between the Central Massif and the Briançonnais anticline of the Alpine region¹ were submerged at various

¹ See p. 245.

periods, and during Jurassic and Cretaceous times great thicknesses of limestone, both marine and lacustrine, were laid down. It was not until the Tertiary period that the modern landscape began to be shaped. The Pyrenees first, extending their folds eastward, shut in great lakes and inland seas to the north. Later the Alpine upheavals, thrusting against the resistant Hercynian rump-blocks of Vosges and Central Massif, threw their Jura and Alpine folds into north-east to south-west lines, parallel in many cases to, and sometimes actually coinciding with, the Hercynian folds and ridges below. Then great cracks let down the Rhône-Saône trench along the edge of the re-elevated Central Massif and along the edge of the Jura. The basin of Bresse was thus formed between great plateau blocks of uplifted Jurassic rocks (the plateau of Langres and the Jura plateau). In mid-Tertiary times a long arm of the sea extended north to Geneva, and at a later stage a great inland lake occupied the basin, draining into a gulf of the sea (which covered what is now the lowland of Provence), over the sill of Vienne, until its waters were diverted northwards by the foundering of the Rhine Rift valley. The Rhine, which entered the trench via the Doubs valley, bringing down great masses of detritus, was at one time the chief instrument in the filling up of the lake of Bresse, but further tectonic movements in Quarternary times depressed the plain of Alsace, south of Mulhouse and reversed the drainage of the Sundgau.

By the valleys of the upper Rhône, Isère, and Durance also enormous quantities of detritus were brought down from the Alps, covering the lake bottom and the valley floors and later forming huge dejection cones at the confluence of the rivers. Subsequent elevation led to deepening of the river-courses and to the deposit of rock waste at relatively lower levels. Thus arose the series of terraces composed of late Tertiary sands, gravels, and clays, which form so important a feature from the point of view of agriculture and the situation of towns and villages. Coarse glacial detritus, washed down from the terminal moraines of Alpine glaciers, is the main constituent of the lowest terraces, but a covering of brick earth (loess) frequently compensates for a sandy or gravelly subsoil. Finally the modern river system is responsible for the deposition of a carpet of alluvium covering the floor of the river flood-plain and for banks of pebbles and gravel which appear in the river-bed at low water.

The Rhône-Saône depression, then, is a tectonic feature in the first instance, dating from the period of the formation of the Alps and the Pyrenees, although to some extent coinciding with earlier tectonic features. Its main divisions are due to earth movements which resulted in the formation of sills separating

the valley into basins. Deposition, for which the Rhône and its tributaries are chiefly responsible, re-elevation, and subsequent erosion, have produced the characteristic terraces which accompany the river and form noteworthy features, especially on the eastern side. The river is still busy grading its course in its upper reaches, eating into its terraces in the middle reaches and building up land in its lower course and at its mouth.

THE SAÔNE BASIN

That part of the Saône-Rhône depression which is drained by the Saône lies between two plateaux of limestone. On the east is the plateau country of the northern and western Jura and on the west lie the limestone plateaux of the Langres and of the Côte d'Or, continued southward by the hills of Mâconnais and Beaujolais. To the north the boundary is formed by the Monts Faucilles, which are a continuation of the Vosges and Lorraine Triassic plateaux of red clays and sandstones. In the south, in the neighbourhood of Givors on the Rhône, a sill of Jurassic rock, traversed in a narrow valley by the Rhône, forms the limit.

This Saône depression, referred to by the French geologists as the *Bressane* basin, is about one hundred and sixty miles long and forty miles wide, and forms one of the most definite physical units in the geography of France. Reflecting the tectonic origin of the basin,¹ the tributaries of the Saône converge upon Chalon, which lies at the deepest part of what was once a lake, generally spoken of as the *Lac de Bresse*. Most of the head-waters of the Saône and its tributaries have not penetrated far beyond the rim of the basin. Only the Doubs and the Ain have tapped the innermost sources of the Jura. The basin of Bresse has three natural outlets. By a broad strait in the north-east, the *Trouée de Belfort*, or *Gate of Burgundy*, it communicates with the Rhine Rift valley. In the south, the Rhône trench between Givors and Vienne leads to the plains of Languedoc and Provence. In the north-west, the head-waters of the Marne, cutting back through the limestone plateau into the soft Lias Clays, have formed a narrow breach, which gives access to the Paris basin.² In the north, the interlocking head-waters of Saône, Meuse, and Moselle make communication comparatively easy over the Faucilles between Burgundy and Lorraine. In addition to those outlets, routes from Dijon and Chagny take advantage of *cols*, due to the wearing down of soft rocks preserved in the Hercynian folds of the Central Massif,³ to reach the basin of the Loire.

The basin of Bresse is floored with clay deposits, which become

¹ See above, p. 261.

² See pp. 109, 110.

³ See Figs. 51 and 64.

sandy in the north, but the southern slopes of the Vosges are flanked by Carboniferous and Permian rocks preserved in a Hercynian synclinal, sandstones, limestone, and coal measures.

The Saône collects its head-waters from the low plateaux of the Monts Faucilles, very near to the head-waters of the Meuse. Its plateau course is but short, and it soon descends into the plain of Franche Comté,¹ where, at Jussey, it receives the Amance, which rises in the Lias Clays not far from Langres. The Amance, flowing at the foot of the limestone plateau, is followed by the railway from Troyes to Belfort that passes by Langres. By the rivers Ranin, Brechin, Semouse, Lanterne, and Oignon the Saône drains the southern Triassic sandstone and marl slopes of the Vosges. The Oignon flows in a straight valley determined by a faulted synclinal, that marks the north-eastern limit of the Bressane depression.

The comparative infertility of the sandy soil, the long, bleak winters of the uplands, made cottage industries, to eke out the scanty agricultural living, almost a necessity. Spinning and weaving, saw-milling, sabot-making, furniture-, tool- and watch-making are aided by the electric power provided by the Ronchamp electric station. Ronchamp lies at a point where, owing to faulting, the Carboniferous coal measures come near enough to the surface to be profitably worked, and here the extraction of 200,000 tons of coal per annum, supplemented by hydro-electric power from over the Swiss border, makes it possible to supply power to the valley textile industries of the southern Vosges. Luxeuil, on the Brechin, is the centre of spinning, weaving, embroidery, and lace-making. Its population does not greatly exceed 5,000, but between this little town and Lure, following the line of railway at the foot of the Vosges, which in its turn follows the outcrop of Upper Triassic marls, there are some 10,000 people engaged in the industries above mentioned, generally following their vocations at home in their cottages. Lure, like Belfort, lies in the Triassic vale. Like Vesoul and Gray, it arose as an agricultural centre; but whereas Gray was the grain centre in the alluvial plain, Lure was a cattle and orchard centre. It prospered on the advent of the railway, and, after 1870, became a centre of Vosges manufactures of various kinds.

The great granite mass of the Bâlon d'Alsace dominates the steep descent to the gate of Burgundy, and is faced to the south by the low foothills of the Sundgau and Lomont, above which rise the plateaux of the Jura.

¹ Franche-Comté corresponds to the three departments of Haute-Saône, Doubs and Jura.

The Gate of Burgundy. The Savoureuse valley, which also drains the southern flanks of the Vosges, lies, however, in the *Territory of Belfort*. This territory is all that was left after 1872 of the French department of Haut-Rhin. It is a narrow

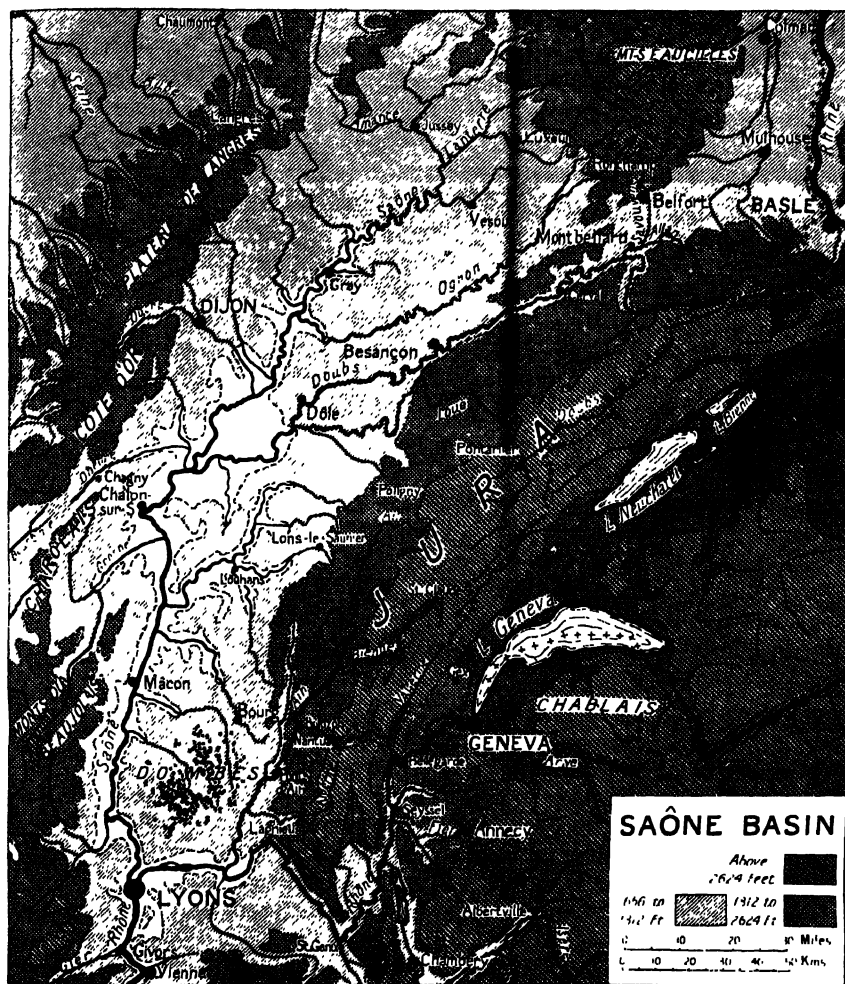


FIG. 51. THE SAÔNE BASIN WITH THE SURROUNDING HIGHLANDS, SHOWING THE VARIOUS PASSAGES LEADING FROM THE BASIN

strip comprising little more than the valley of the Savoureuse, which, rising in the Bâlon, flows south to join the Doubs not very far from the Swiss frontier. The river crosses

the Permian and Carboniferous rocks and then the marshy lake-strewn trench of the Lias Clay, separating the foot of the Vosges from the low limestone plateau which forms the floor of the Belfort Gap, and continues at a greater elevation in the northern plateau section of the Jura.¹ Belfort lies in a shallow curve of the Savoureuse, just where that river leaves the Lias Clay vale to enter the low limestone hills. At an elevation of some 1,150 feet above sea-level, and above the valley-bottom, the fortress dominates the modern industrial town that has developed in the shadow of its ramparts between the river and the Epinal

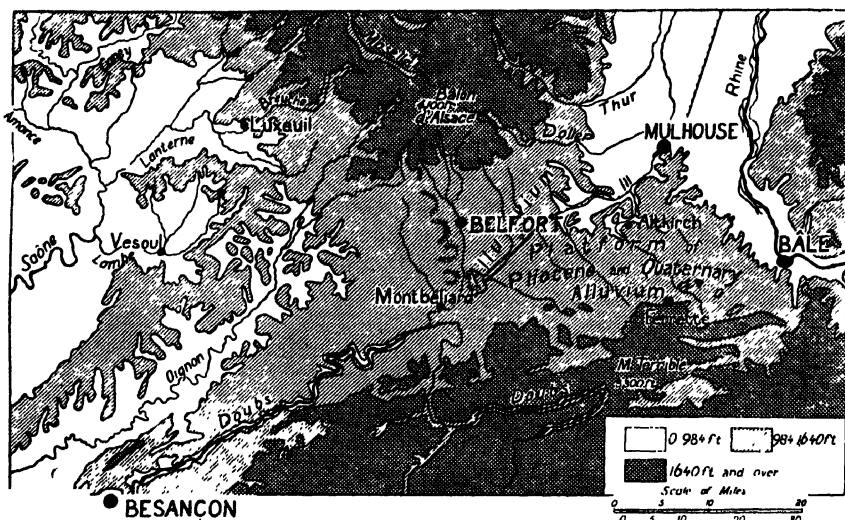


FIG. 52. THE GATE OF BURGUNDY OR BELFORT GAP, SHOWING THE DUAL NATURE OF THE PASSAGE-WAY AND THE RELATION OF THE BELFORT INDUSTRIAL AREA TO THOSE OF MULHOUSE, BASLE AND THE DOUBS VALLEY

railway. Forts occupy also the hill-crests on either side of the valley. The thirteenth-century fortress was succeeded by Vauban's massive fortifications, bearing witness to the importance of the strategic position of Belfort in relation to the Rhine-Rhône passage-way. Vauban's fortifications gave place after 1870 to more modern defences along the crests of the low hills to the east of the town. To-day, with the frontier withdrawn to the Rhine, the narrow strip of land has lost some of its significance. As a vulnerable point in the French frontier, the Burgundian Gate has never had the importance of the northern entrance to the Paris basin, and as a coveted control point it was

¹ See p. 269.

less to be desired than the Strasbourg-Saverne-Nancy line, for it lay too much on the extreme flank of an advancing army to make it a point of concentrated attack.¹ The map shows clearly enough the great value of the site of the town from the economic point of view, and suggests that its growth to a town of 39,173 inhabitants in the last seventy years is not entirely due to political happenings. No doubt great barracks and the development of military railways were also an asset to the development of the modern town, but the convergence of routes, both road, rail, and water, on the gap must have caused an agglomeration of importance, if only as a point of exchange. The sudden great increase in population after 1870 was not maintained. In 1880 the population of Belfort was over 68,000. In 1921 it amounted to only 33,400. Of late years, spurred by the development of the Ronchamp-Eboulet production of electric power, and by the consequent development of textile and other electrical works, Belfort has specialized in the production of electrical machinery, appliances and fittings of all sorts. Here are made the electric locomotives that ply on the local railways, as well as boilers, steam-turbines, gas engines, etc. There are important textile mills making embroidery cotton.

We must regard the territory of Belfort as forming, both agriculturally and industrially, the centre of an economic area which includes Besançon, Montbéliard, Mulhouse, and, one is tempted to add, Basle. To this region, northern Franche Comté and the Sundgau are at least in part tributary. We recognize thus the peacetime significance of the gap.

Behind Belfort the fortresses of Langres, Vesoul, and Besançon guard the routes to the Seine and Rhône valleys. All these were Roman strongholds. Vesoul, in the plain, is a small market town of no great economic importance, manufacturing agricultural machinery.

Gray is a bridge town on the Saône, just where that river leaves the Jurassic rocks of the rim of the basin to enter the Lower Tertiary alluvial-covered rocks of its floor. Here we are in ploughland as contrasted with the dairy, orchard, and forest land of the Vosges foothills, and Gray is an important grain market and milling centre. Originally its importance lay in the bridge and the convergence of important roads on the crossing of the Saône. Railways from Nancy, Vesoul, and Belfort converge

¹ The importance of the Gap, even in early times, appears to have been exaggerated. The valley bottoms were impassable, the plateau does not seem to have afforded easy passage and the Sundgau forests formed an effective barrier. It was only when the Romans drove their roads through it that the Belfort Gap became a thoroughfare. The modern railways, like the Roman roads (Gibert, *La Porte de Bourgogne*, p. 203) emphasize the dual nature of the gap.

on Gray to-day, but the little town has been drawn into the orbit of Dijon.

Between Gray and Chalon-sur-Saône stretches the *Plain of Burgundy*. The Saône winds, a broad and sluggish river, through its alluvial flood-plain of rank pastures, where large herds of cattle graze amid lines of poplars and willows. The Tertiary clays rise from the flood-plain, sloping gradually upwards from about 500 to 800 feet above sea-level. To the west and north-west rise, like a wall, the faulted limestone edges of the Côte d'Or and the Plateau de Langres. Where the Tertiary deposits are sandy, patches of forest appear, and woodland also occupies considerable areas on the alluvial flats. The strip of gently-rising land between the Saône and the foot of the upland, composed largely of Tertiary clays, is extremely fertile, chiefly on account of its aspect, but also on account of the beneficent mixture of soils—limestone down-wash mingled with the clays and sands. The higher parts of the slopes, above 1,800 feet, are covered with brush and woodland. Villages, rarely more than a couple of miles distant from one another, are scattered all over the plain, the large ones and the small towns, as one might expect, being found stretched along the main road and railway that skirt the foot of the steeper slopes. White, red-roofed farms are dotted over the rising ground above road and railway. Wheat, lucerne, maize, and vines occupy the cultivated land.

Between Dijon and Chagny lie the slopes of the *Côte d'Or*, carrying the most renowned vine district of Burgundy. As the Saône approaches the latitude of Dijon, it gets nearer and nearer to the western edge of the old lake basin. The long slope from the foot of the Côte d'Or becomes steeper; limestone bluffs and palisades jut out from the smooth hillside; grey limestone gorges open at intervals into the plateau behind. At the mouth of each gorge stands a village. Vines occupy more and more of the land as one continues southward. Gevray, Chambertin, Beaune, Volnay, Mersault, and other places recall the names of famous Burgundian vintages. Villages are clean and prosperous-looking, and new, up-to-date factories are frequently met with. Chalon is a bridge town where the Belfort-Marseilles and Paris-Geneva railways cross the Saône. The crossing at Tournus of the road to Cluny is a very ancient one.

Dijon. Both Dijon and Chagny are gap towns. *Dijon* commands the road that climbs up the Ouche valley to Sombernon, where, near the water-parting, between Rhône and Seine, there is a magnificent view from the inner edge of the Côte d'Or over the great Lias vale of the Armançon, which separates the Jurassic limestone plateaux from the crystalline edge of the

Morvan. The Ouche valley, which leads round behind the Côte d'Or, carries the road and the Canal de Bourgogne which tunnels through the narrow divide to follow the Armançon to the Armance and Seine.

Dijon had a strong position partly surrounded by the Suzon, whose waters were drawn into a moat which surrounded the ramparts now turned into boulevards. In the last sixty years it has more than doubled its population, which stood at 88,872 in 1936. This is partly due to the modern organization and marketing of the famous Burgundian wines, and partly to the increase of manufactures, largely of alimentary articles, such as biscuits and mustard. Its position at the crossing of the north and south corridor route by the east and west route between Paris and the Rhine, via Alise Ste. Reine, no doubt gave it an increased attraction for commerce and industry so soon as the railways came. To-day it is perhaps the busiest railway junction in France.

Chagny, which lies also at the foot of the Côte d'Or, away from the flood-plain of the Saône, commands the route to Nevers on the Loire, via the ancient *carrefour* of Autun. The railway follows the Dheune valley through the Côte d'Or, here at its narrowest, and then forks, one branch passing north-west to Autun and the other turning south-west to Le Creusot, following the edge of the Carboniferous basin. Partly on account of the industries based on coal and partly because the Le Creusot basin forms one of the ancient links between the Rhône-Saône corridor and the Loire and Seine basins, this region is thickly inhabited. Within a radius of six miles of Nolay one can count no fewer than thirty-five villages, besides farms and hamlets. The Canal du Centre utilizes the Dheune valley to pass to the Bourbince and Loire.

By the bridges of Chalon and St. Jean de Losne and the gaps behind Dijon and Chagny, Nivernais and Burgundy are linked with the industrial region of Franche-Comté and Belfort.

THE JURA

On the east of the Bressane depression, curving like a broad sickle, lie the Jura uplands. Their dark line can be seen on most days from the slopes of the opposite Côte d'Or. Broadly, they can be divided into two geographical sections: a northern plateau section and a southern folded section. The plateau section drops down in a series of terraces to the Gate of Burgundy, under the floor of which the Jurassic limestone continues.

The plateau arrangement of the northern Jura is due to intense faulting, which is characteristic of the edges of the whole Bressane depression, as it is of all the edges of the Hercynian Massif.¹ South of Belfort the Lias is succeeded on the edge of the Jura upland by undulating plateaux, stretching from the Oignon valley southwards as far as Besançon, and having an average elevation of about 1,500 feet. As one passes towards the interior of the mountain system the plateaux become higher and take the form of broad synclines, separated by the crests of faulted anticlines. Within, to the south-east of these plateaux, the typically folded Jura begins, at first in broad folds, but gradually becoming more and more compressed into a close succession of ridge and vale, wave behind wave, the Hautes Chaînes rising to 3,000 and 4,500 feet. The three zones, of high, folded chains in the east, plateaux in the centre, and low, folded ridges in the west, are particularly developed in the middle part of the Jura, where they widen in the latitude of Pontarlier and are distinguished as *La Montagne* or *Les Hautes Chaînes*, *Les Plateaux* and *Les Vignobles*, the latter forming the Lomont district in the north and the Revermont in the south.

THE DOUBS. The chief rivers of the Jura are the Doubs, which rises at the foot of the Crêt Sapeau in the Mont Risoux and flows north-east, and the Ain, whose numerous head-waters drain the slopes of a kind of cirque in the vale which the narrow ridge of the Haut Joux separates from that of the Doubs head-stream. The Saute, an upper tributary of the Ain, flows in the same synclinal trough as the Doubs, but in the opposite direction. To the south-east of Mont Risoux, whose forested ridge for eighteen miles forms the frontier between France and Switzerland, the Bienne, major tributary of the Ain, has cut its gorge back almost into the basin of the Orb, which drains to Lake Neuchâtel. The drainage of both Ain and Doubs follows alternating longitudinal and transverse valleys; the Doubs working a zigzag course north-east via Pontarlier and Morteau, and the Ain trending south and west after a short northward excursion to Champagnole.

The upper north-eastward course of the Doubs, from its source till it reaches the latitude of Besançon, lies within the Montagne or Hautes Chaînes of the folded Jura. It is tectonically controlled, following, in turn a succession of synclinal vales. These are floored with glacial detritus and it is similar deposits that have formed the lakes of Remoray and St. Point which are drained by the Doubs. Keeping a general north-eastward trend, the river passes from one synclinal valley to another, utilizing

¹ e.g., The Causses.

the *cols* that separate the succeeding anticlines. Road and railway, linking Berne with Dijon, accompany the Doubs through the famous gap of La Cluse, by which it reaches the broad, synclinal vale of Pontarlier. From that town the railway follows the river to its most north-easterly point, where, having left the Hautes Chaînes, it doubles back on itself in the plateau zone, leaving the river Sorne to drain the continuation of the syncline to the Rhine. There seems to be no doubt that the upper Doubs was once tributary to the Rhine, as the Orb is now, and that it was captured by a river of the plateau zone and drawn off to the Saône. The relative hydrological conditions of the Hautes Chaînes and plateau zone, as M. E. Fournier points out,¹ facilitated this capture, and may eventually lead to the capture of the Doubs itself by its own plateau tributary the Loue. Whereas the greater original height of the Hautes Chaînes, together with the preserving effects of glaciation, have maintained the level of the valley floors in that region at a relatively high level (2,300 to 2,600 feet), in the plateau zone underground erosion has reached an elaborate stage of development and has been very rapid and the rivers have approached base level very quickly. The Loue, which rises only five miles from the Doubs, emerges from the limestone, a fully-grown river, 1,150 feet below the level of the Doubs, and probably already taps the Doubs drainage by underground tributaries. With the exception of the Oxford Clay, the plateau is composed entirely of Jurassic limestones. The absence of sub-aerial tributaries, the steep-sided cañons, underground rivers, grottoes, sinks, and swallows give the plateau zone many karstic characteristics.

Near *Montbéliard*, the Doubs leaves the plateau zone and enters the low, folded and faulted undulating region of the *Vignobles*, which is very narrow in the north of the Doubs basin, consisting of only two anticlines, but widens rapidly southward in the neighbourhood of Lons le Saunier and the head-waters of the Ain, in the district known as *the Revermont*. Here the plateau does not rise above 1,600 feet.

We see, then, that the Doubs basin embraces all the northern part of the French Jura, and includes, in the north-west, the low, faulted plateaux of the edges of the Bressane depression, *the Lomont* (which continues south-westward into the Revermont, more definitely folded), the high and almost level plateaux between Besançon and Pontarlier, drained to a large extent by the Loue, and, along the Swiss frontier, a number of ridges and valleys of the Montagne or Hautes Chaînes. These three types of country are all included in the department of Doubs, which

¹ M. E. Fournier: 'Le Doubs et la Loue' (*A. de G.*, Vol. IX, p. 219).

corresponds roughly to the basin of the river. The upper Saône plain, together with the Belfort region and the upper Doubs basin in the Jura, formed the old province of *Franche Comté*.

Climatic conditions in the Doubs basin are representative of those in the rest of the eastern Saône basin. The precipitation in the uplands, especially in the Hautes Chaînes, between 3,000 and 4,500 feet above sea-level, is high, reaching seventy inches. In the winter snow lies for several months, forming an important reservoir of water for the streams. At that elevation, and indeed on all the Jura, the winters are bleak, and at times, owing to a creeping down of cold air, the valleys are also very cold. The summers, on the other hand, are hot in the valleys and on the lower plateaux and ridges, especially in the Vignobles. The régime of the rivers is rarely torrential, owing largely to the permeability of the rocks, but the supply of water is generally plentiful. With the melting of the snow in the spring and with heavy autumn and winter rains the streams rise considerably, but the rise is generally slow and is slowly propagated downstream. The effect of climate and soil is to produce in the Montagne, hardy conifers on the rainswept and exposed slopes, and pastures on the lower slopes, while on the high plateau we find pastures, except on the valley slopes, where the steeper sides are always wooded. As a result of aridity, due to the porous rocks and also to steepness of slope, the main occupation is pastoral rather than agricultural. The breeding of cattle for draught, butchery, and dairy purposes, and the making of butter and cheese are the main occupations.

There are three types of pasture in the Jura¹—communal pastures round the villages, which deteriorate through overcropping; enclosed pastures, or *parcs*, where the beasts remain day and night, some distance from the villages but in sheltered positions, giving better conditions provided the individual or society has sufficient land; and high or alpine pastures between 2,500 and 4,500 feet, where the cattle can only remain in the summer months, but which supply the healthiest conditions for the animals. The alpine pastures have been greatly improved of late years by scientific draining, planting of trees, clearing of stones, etc., and have become famous for the intensive production of Gruyère cheese, for about half the cattle reared in the French Jura (between 700,000 and 800,000) are milch cattle. The cattle are of the sturdy red and white Montbéliard race, '*bonnes à tout*', to suit the requirements of the small proprietor. The most important product of the dairy industry in the Jura is cheese, and chiefly Gruyère cheese. The industry has been traced back to

¹ Lorbert: *La France au Travail—Champagne, Franche Comté et Jura*, p. 212.

the thirteenth century.¹ In the production of these great cheeses, each requiring thirty-five to fifty kilograms of milk and two to three months to make, co-operation of the small farmers has always, to a certain extent, been necessary, even when the production was for local consumption only. Each farmer contributed milk for which he received credit, but the cheese became the property of the farmer who contributed the largest amount. To-day, when the cheese has a world market, organization of the co-operative societies (*fruitières*)² is tending to be on a large scale, and the middleman, who brings the merchants into touch with the smaller societies plays an important rôle. In the larger societies the cheese now becomes the property of the society. The upper Doubs basin produces between 150,000 and 200,000 cheeses per annum. The dairy châteaux are dotted all over the valley-slopes of the folded Jura. Pontarlier, standing at the mouth of the Cluse, is the focusing point of the dairying industry of the Doubs basin.³

Before 1914, between two and three thousand people in *Pontarlier* and the neighbourhood were employed in the cultivation of wormwood and other herbs for the distillation of absinthe, the warm, dry soils being particularly friendly to the cultivation of herbs; but, as a War regulation, the fabrication of absinthe was prohibited and the industry died, leaving as sole native activities those connected with the production of milk and timber. Cheese and chocolate factories, tanneries and saw-mills occupy most of the work-people of the little town, but a compensating innovation, due also to the War, is the establishment of the engineering works of a well-known automobile company.

In the very porous and soluble Upper Jurassic limestone which forms the plateau surface here, the river Doubs has etched a series of gorges, notably that of the Coin de la Roche, and the slopes of the valley are riddled with caves and grottoes. Just above the Coin de la Roche gorge the Doubs disappears underground for a mile. Below Morteau the river flows within the Swiss frontier for some miles, during which it drops over the well-known falls (Saut de Doubs), some ninety feet.

Near the north-eastern extremity of its course the Doubs

¹ Ch. Martin : *Laiterie*, 1924, p. 329.

² The origin of the term *fruitière*, as of the type of association, has been much discussed. It has been derived from the Fribourg word *fyet*, meaning cheese, and it is also claimed that it is a local term of Latin origin from the word *fructus* used in ancient charters in reference to tribute cheeses due from tenants. M. Martin suggests that the Swiss name *Gruyère* is modern, and that the industry was introduced into the Swiss canton of Vaud after the Reformation from Franche Comté.

³ To-day there is concentration on milk production for the surrounding industrial districts, surplus milk sometimes travelling as far as Paris. (A. Gibert, *op. cit.*, p. 430).

recrosses the frontier and, after a couple of zigzag turns, enters the truly industrial part of its basin at Pont de Roide above Montbéliard, in the low plateau region of Lomont. Here a number of tributaries, bringing clear water from the limestone, led to the development of small industries at an early stage when the streams were utilized locally for power without transformation into electric current.

Montbéliard, situated at the junction of the Allan and Lusine streams, just above their point of confluence with the Doubs, focuses the life of these industrial valleys and links it with the wider interests of the Rhine and Saône plains via the Belfort gap. The Rhine-Rhône canal follows the river Allan through the busy little town. From the end of the fourteenth century this *pays de passage* belonged to the Counts of Würtemberg, till, towards the end of the eighteenth century it became reunited to France. It is not surprising, when one considers its geographical position between Alsace, the Swiss Jura, and the plains of Burgundy, that the *Pays de Montbéliard* should have developed, along with Mulhouse and Belfort, flourishing textile and watch-making industries, based on water-power, in addition to the industries more closely related to the Jura uplands, namely, forestry, dairying, and cabinet-making. From the textile industry developed tool and machine-making industries (also supported by water-power), which, passing through the stage of bicycle-making, arrived, at the end of the last century, at the most modern stage of mechanical industry, that of the construction of automobiles, associated with the name of a universally known firm. Sochaux is associated with Montbéliard in this industry, which received an impetus during 1914-18 in the construction of aeroplane engines. To-day Montbéliard and half a dozen surrounding villages employ from six to seven thousand hands in the manufacture of cycles, motors and aeroplanes. The stamping of the parts is done at Montbéliard, and they are assembled in the small cantons. This development is not without its effect, of course, on the agriculture and viticulture of the Jura and is in part responsible for the passing of agricultural land into pasture. The population of Montbéliard and the surrounding villages is mainly Protestant—another link with Switzerland.

At the confluence of the Allan, the Doubs makes a sharp elbow and doubles back south-westwards just within the edge of the Jura to Besançon, passing on the way the small iron-works of l'Île-sur-Doubs and Clerval, which make nails and bolts and wire, and gas and electric fittings, etc., deriving their ore from the Laissey mines.

The old town of *Besançon* (the Roman Vesontium) lies in a

loop of the Doubs. Its function throughout its history has been to control the passage-way between the Vosges and the Jura that leads to the Rhine plain. Vauban's fortress occupies the neck of the peninsula. The modern forts and the barracks occupy the neighbouring bluffs overlooking the river. The modern town has developed along the flat which links the Doubs valley with that of the Oignon to the north. Besançon has a population of over 56,000. Its main industry is watch-making, which became

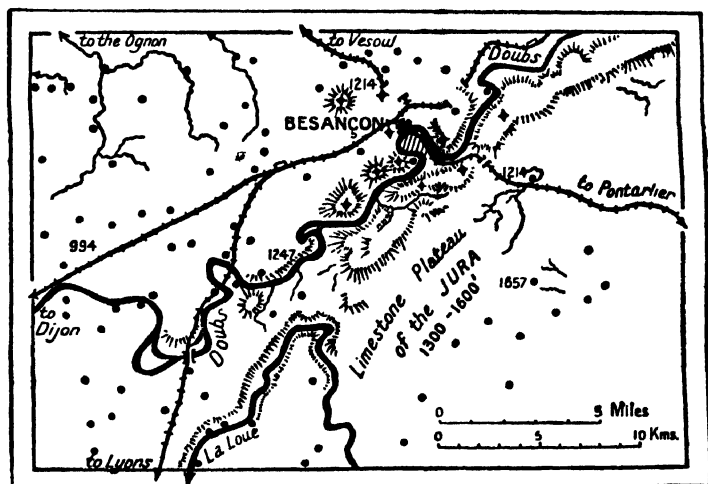


FIG. 53. BESANÇON SHOWING THE STRONG POSITION OF THE FORTRESS AT THE ENTRANCE TO A GAP IN THE JURA, AND THE RAILWAYS CONVERGING ON THE TOWN

important towards the end of the eighteenth century owing to the introduction from Switzerland of the idea of standardization of watch parts. It also has steel works and factories for coach-work and motor-car works. Industry, throughout the department of Doubs, is greatly indebted to Swiss influence, as we have seen in the case of Montbéliard. Alsace has also had an influence upon Besançon, and to that province the town owes its textile industry, now chiefly elastic fabric, hosiery, and artificial silk. Brewing and distilling, aided by the navigability of the Doubs and the canal, employ a considerable number of hands. So the ancient town owes its industries and prosperity, as well as the disasters that have overtaken it in the past, to its relation to the gate of Burgundy.

North-west of the Doubs, a low, broken plateau, 600 to 1,000 feet high, known as La Plaine, slopes gently down to the Bassin

de Bresse. With its numerous watercourses and crowded hamlets and villages it stands, despite the wooded nature of the country, in sharp contrast to the sparsely-peopled Jura plateau to the south-east. Some six miles below Besançon, as the crow flies, the Doubs emerges altogether from the Jura and, passing between the great Forests of Chaux and La Plaine, covering masses of sand and gravel derived from the Vosges, receives the river Loue, whose broad, two-mile wide flood-plain separates the hill country of Burgundy from the lake bottom of La Bresse, with its alluvial clay subsoil and its glacial detritus. The Loue, as we have seen, rises not far from Pontarlier and drains the low Jura plateau, whose valley-slopes are cultivated with maize and wheat, vines and orchards, and, higher up, forests of oak and beech. Cultivation in these valleys is steadily giving place to pasture, owing in the first place to a scarcity of labour attributable to the War, and secondly to the greater attraction offered by urban life, and partly also to the better remuneration provided by the demand of the towns for dairy produce. In the last thirty years agriculture in the Jura has lost some 50 per cent of its acreage.¹

THE AIN. The Ain and the Valserine, both draining to the Rhône direct, carry off the waters of the southern folded Jura. Pine forests and summer pastures occupy the uplands, which, however, offer great, but hitherto only partially developed, resources for the tourist. The long-lying snows on the north-western slopes, the beauty of the scenery, the karst phenomena of underground rivers, innumerable grottoes, *avens*, springs, *vaucluses*, etc., to say nothing of the spas provided by the saline layers underlying the Jurassic limestone, are attractions which should draw an increasing number of visitors, both in summer and winter.

The Bienne, the main tributary of the Ain, rises ten miles west of Lake Geneva. An electric railway leads up north-westwards from Switzerland via Morez, by a miracle of engineering, through the Mont Noir ridge and so by a circuitous and difficult route to the important junction of Lons le Saunier. A branch running north from Champagnole connects with Besançon and Dôle. A main road links the railway at Morez, the centre of the spectacle industry, with the Col de St. Cergue near the head of the valley, from which there is a difficult descent to Nyon on the lake shore.

An enclave of Swiss territory, extending along the Rhône, cuts off France from the south-west extremity of the lake of Geneva. A projecting portion of French territory, however, approaches

¹ Lorbert, *op. cit.*, p. 199.

near to the lake in the Pays de Gex, to include Fernay Voltaire, which is isolated from France by the Hautes Chaînes.

Industries. The industry of the region has developed in a way quite unknown in the higher parts of the Vosges and of the Central Massif. Clock and spectacle-making, and enamelling are industries that flourish in the Bienne valley in the neighbourhood of Monz. Particularly interesting has been the development of the use of plastics.

St. Claude is the largest industrial centre of the Bienne-Ain basin, employing over 1,000 persons chiefly in the making of briar pipes from heath roots sent from Mediterranean districts. They were originally made from the box which grew on the slopes of the High Jura. St. Claude has given its name in commerce to a multitude of fancy articles made of metal, wood, cellulose, galalith, etc., which have a world-wide market. From the forest industry of wood-carving and cabinet-making there developed, in the Oyonnax district, the making of wooden combs, from which in turn developed the manufacture of horn, celluloid, and recently casein articles of all sorts, useful and ornamental. The latter has developed so rapidly that it has to draw upon the dairy industry of the Charentes for the very large quantities of raw material that it requires. About 5,000 men and women are employed in cottages and small factories in this industry. Lons le Saunier manufactures optical glasses for the spectacle firms. Other domestic industries requiring time and skill are precious stone setting, which is practised in the Montagne, in Lons le Saunier, and in the Pays de Gex. Gex, with 1,400 inhabitants, lies just outside and to the east of the folded Jura below the edge of the last strip of limestone plateau where it drops to the well-watered lower terrace, La Côte, above the lake of Geneva, drained by the numerous tributaries of the Seille, whose head-waters take their rise in the Jurassic edge. The *Pays de Gex*, cut off from Geneva and the lake by the Franco-Swiss frontier, appears to hold a strategic position related to the Nyon-Bellegarde railway.

Beneath Lons le Saunier and Poligny lie salt deposits whose ancient works gave the first town its name (from Ledo Salinarius).

From Lons le Saunier, with its salt works and spas, we descend to the hill country of the Côte or the Revermont. Here, up to 1,500 feet, the valley slopes are under cultivation—wheat, maize, and orchards, above them vine terraces, and on the higher and steeper slopes, beech and oak woods, no longer the dark conifers of the Hautes Chaînes. Although cultivation generally, and the cultivation of the vine in particular, is diminishing in favour of stock-raising and dairy-farming, there is still important wine-production in the neighbourhood of Lons le Saunier and round Poligny and farther south in Le Bugey.

THE INFLUENCE OF LYONS. Below the confluence of the Bienne, the Ain continues its zigzag diagonal course across the Jura folds, passing by means of *cluses* from one longitudinal valley to another, between ridges 2,500 feet high. It receives the Oignon and, leaving the Hautes Chaînes, proceeds in a long, deep, winding gorge to cross the lower, undulating plateau of the Côte, from which it emerges on to the plain of Bresse at Pont d'Ain, where the main road and railway skirting the eastern edge of the Saône depression cross, and pass to the upper Rhône. It flows along the edge of the Jura for some six miles, and receives the Albarine from the Bugey district. All the larger valleys of the southern Jura are being drawn into the industrial radius of Lyons, like those of the Central Massif and the Alps which drain to the Middle Rhône. From Nantua and Bellegarde in the upper Rhône basin, from Bollozon on the Ain, and along the Albarine valley we find the silk-spinning and weaving industry. The secret of the development was, and still is, the water-power provided by the swift, clear streams of the folded Jura, with their numerous cascades and gorges. Small industries are based on water-mills, as in the Vosges. Ambérieu-en-Bugey, St. Rambert, and Tenay, near the Cluse d'Albarine, have grown rapidly. There are a number of hydro-electric installations along the course of the Ain which also send power to Lyons.

We see, then, that the Jura uplands, generally speaking, have an extraordinarily active population, and we are not surprised to find that it exceeds fifty-seven to the square kilometre. In the north we have the textile, watch-making, and metallurgical industries associated with Belfort and Alsace; while in the highlands, towards the Swiss frontier, there is a set of long-established industries, often of a highly skilled nature, based on the local raw material most readily available—timber from the forests. Such are the manufacture of wooden clocks, furniture, wooden (and latterly horn) combs, and toys. These cottage industries have developed of late years, to include all kinds of clock and watch-making throughout the upper Doubs basin, with Montbéliard and Besançon as chief centres,¹ spectacle glass making, gem cutting, the fabrication of all sorts of fancy articles from ebonite, caseine, etc. In the south we find the silk industry becoming more and more active as we come within easy accessibility of Lyons. Whether the intense development of industry in the high Jura be due most to the natural energy and initiative of the inhabitants, or to the influence of the practical Swiss exerted by political immigrants at the end of the eighteenth century, or to the effect of the long,

¹ There are a hundred manufacturers of watch sections in the Doubs region. Mathieu, *op. cit.*

dark, cold winters of the Jura, or to the relatively good railway communications, it would be difficult to say. The Jura have no particular advantage to offer to settlement except their abundant supply of water in the valleys, a certain amount of iron-ore which was utilized in early days, and the peculiar and characteristic feature of the *cluses*: those narrow, steep-sided passages that lead from one longitudinal valley to another, concentrating traffic, capable of being defended, and in their swift, confined stream-reaches providing suitable sites for the installation of hydraulic and hydro-electric power stations.

These *cluses* are, however, by no means well placed for the passage of trans-Jura railways and roads, and the succession of steep, parallel ridges alternating with deep, narrow valleys, has placed a formidable obstacle in the way of railway construction, and base-level tunnelling is a costly affair. Nevertheless, we shall probably be safe in citing as one of the chief causes of the relatively dense population of the Jura upland its position athwart the great routes that pass from London and Paris to Vienna, Milan, and Genoa. The carrying of railways across the Alps necessitated the crossing of the Jura too; hence the main lines Dijon-Pontarlier to Neuchâtel and Lausanne, Mâcon or Lyons via Ambérieu and Virieu to Geneva and Chambéry. To which must be added the more direct but difficult route from Mâcon via Nantua to Geneva. From Lons le Saunier and Besançon a number of light railways penetrate the Jura and wind in and out through *vaux* and *cluses*, bringing the numerous little upland towns into touch with the centres of the plain.

In the Côte, west of the line Poligny-Lons le Saunier-St. Julien, the drainage converges on Louhans. Large villages succeed one another along the high-roads and half-way up the valley slopes. From the Jura edge there is a sudden drop from 1,800 or 2,000 feet to altitudes of six and seven hundred, but the slope is gradual across the Tertiary clays and sands to the flood-plain of the Saône. Fertility decreases towards the river—the *Revermont*, or edge of the upper slopes, with its limy soils, being much more fertile than the low-lying areas of La Bresse Louhannaise. Louhans lies at 400 feet above sea-level in a shallow basin where half a dozen tributaries join to form the Seille. It marks the division between the Revermont with the Vignoble and La Bresse proper—La Bresse de Louhans, which is almost all pasture-land. In the neighbourhood of Bourg-en-Bresse the fertile soils of the level plain come right down to the Saône. The wet meadows near the rivers give pasture for large herds of cattle and horses, and for long Bourg has been a market for dairy

produce. But what Bresse is famous for to-day is intensive poultry-rearing and fattening for market.

The Dombes. South of a line between Bourg and Thoissay on the Saône, the floor of the basin of Bresse is covered with thick deposits of morainic detritus, relics of Alpine glaciers. Long, shallow meres cover a large portion of the land, and much of the rest is marshy. Here and there low mounds rise above the marsh. This land, once waterlogged and malarious, is now rendered much more healthy and productive by draining the marshes and by emptying the lakes every few years and cultivating the bottoms for two successive years. The fish with which it is the custom to stock the ponds are reared in specially reserved ponds. When the lake bottoms are laid dry, the fish are caught in nets and sent to the Rhône valley markets.

THE RHÔNE BASIN

The French Rhône basin, exclusive of the Saône basin dealt with above, includes a section of the folded Jura, a small part of the 'plateau Jura', the southern portion of the basin of Bresse in which is included the Lyons district, the basin of Valence, and the funnel-shaped depression of Provence. The Bresse basin is separated from the basin of Valence by a half-buried Hercynian ridge of primary rock, covered by Jurassic formations but manifesting itself in a small exposure at La Verpillière. The plain of Valence is divided from the depression of Provence by a broad zone of Jurassic and Cretaceous limestone hills which cross the Rhône valley from the Alpine foothills and are continued in plateau formation on the flanks of the Cévennes. The subsidiary basin of Montélimar lies within this zone.

RÉGIME OF THE RHÔNE. The Rhône, whatever its traffic in the past, cannot be considered a navigable river to-day. For the first thirty miles after it leaves Lake Geneva it falls 350 feet. Between the head of navigation and Lyons the gradient is 1/1000. Below Lyons the steepest gradient in the course of the river is between the confluence of the two tributaries Isère and Ardèche.

As in the instance of the Rhine, the régime of the Rhône varies in the several sections of its course. It has a much steeper gradient than the Rhine, but, like the Rhine above Basle, it is a mountain stream. Its Alpine reservoirs are closed in the winter months, and its main floods occur in late spring and early summer with the releasing of the grip of winter. They are then frequently augmented by the heavy rains that accompany the passage of cyclones, barred during the winter by the continental high pressure system. The course of the river through the fore-Alps and

Jura is hardly less Alpine, and the frequent narrows alternating with shallow basins which occur in its passage across the whole breadth of the Jura make costly regulation works a *sine qua non* for navigation.

Below Lyons the entry of the broad, gentle Saône completely alters the character of the river for a space. At the confluence, the two ill-assorted bedfellows occupy uneasily the same channel. The hurrying, often turbulent, Rhône is easily distinguished, with its milky waters, as it jostles the tranquil green flood of its companion from the north. But the waters soon mingle indistinguishably and the great stream flows in full breadth and dignity towards and through the passage of Givors, with a régime that approximates to that of the Saône. The water is high in the winter and a second maximum occurs in spring. With the confluence of the Isère, however, the river tends to revert to its Alpine nature and régime, modified, however, by short-lived irregularities due to the occasionally inordinate contributions of its tributaries from the Central Massif, which empty their waters precipitately and without ceremony into the main stream. True to the transitional character of the region, the régime of the middle Rhône partakes of the peculiarities of the hydrography of northern as well as of southern France. This obtains as far as Tain l'Hermitage. The water is highest when the Mediterranean rains and Atlantic rains coincide—in other words, when high water from the Saône basin and Alps occurs at the same time as a cloudburst in the Vivarais highlands. Such incidents occur chiefly in the autumn. The Isère, the second largest tributary, is still a mountain torrent when it joins the Rhône, if we consider velocity, volume, and the amount of mud it brings down. The fact that its basin lies partly in the region of Atlantic precipitation and partly in that of Mediterranean rainfall, modifies, to some extent, the irregularities of its flow, but its floods are none the less noteworthy. In its upper and middle course the Isère has maximum high water in June, when the contribution from the snowfields of the high Alps is at its greatest. In the plain of Valence, June is still a period of high water, but in August and October the Alpine contributions die down. At this period, however, there may be sudden and violent rises due to cyclonic disturbances in the Mediterranean. The fore-Alpine streams, as well as some of the southern tributaries, give a maximum in November and October, and often these autumn floods are higher than the summer ones. Spring high water is more noticeable as the Isère nears the Rhône.¹

The general effect of the Isère on the régime of the Rhône is

¹ See chapter on Climate, p. 14.

to add to its complexity ; to the winter high water, due to the Saône, is added a summer high water due to snow melting, and autumn rises due to Mediterranean rains. In spite of a large amount of water lost, temporarily at least, by seepage underground, the Rhône is augmented in volume by 28 per cent with the confluence of the Isère. Low water is most serious in this middle section in August and September, and only slight in winter.¹

The middle Rhône, then, viewed from hour to hour and from day to day, is a most capricious river ; notwithstanding which, the variety of its sources of origin causes such compensation as to ensure a comparative regularity of flow. It is rare that long periods of low water are experienced such as occur with the Loire and even with the upper Rhine.

Below Valence, the spring and autumn rain maximum, characteristic of the northern Mediterranean, is felt by the Rhône through its fore-Alpine tributaries, and the increasing summer drought becomes more and more effective on the régime of the river, owing to the fact that the pre-Alps and the Provençale Alps have nothing to contribute in the way of snow and ice water. In autumn the Drôme and other south Alpine streams rise sharply with the passage of cyclones over the northern part of the western Mediterranean.

The Cévennes streams, whose basins fall within the Mediterranean régime of rainfall, are more sudden in their floods in the north than in the south because the run-off in the crystalline regions is so rapid and the gradient to the Rhône so steep. The Ardèche is the classic example of the unreliable nature of these streams. Some of them dry up completely in summer. On the other hand, a sudden rise of twenty feet is a common occurrence, and the Ardèche has been known to rise thirty feet above normal. Notwithstanding its small catchment area, it is perhaps the most disturbing element in the southern course of the Rhône, causing sudden rises in the main stream of as much as ten feet. The force and volume of these torrents, which hurl themselves from the Massif, frequently ponds back the Rhône stream for several miles, and causes great floods to spread over the water-meadows of the Rhône plains. In summer, on the contrary, the streams are very low, because there are no natural reservoirs except peat bog and forest. Thus the Rhône falls more and more under Mediterranean influences as it proceeds southwards, though the size of its Alpine tributaries secures for it a fair minimum in summer in spite of drought and intense evaporation.

¹ cf. the Rhine, where low water is marked in winter and relatively unimportant in late summer.

The Rhône, then, may be divided into four sections from the point of view of régime :

1. Alpine, with high water in spring and early summer due to melting snow, and low water in late summer owing to seasonal drought, followed by a second period of high water due to autumn rain.
2. The Lyons section, in which the Rhône assumes, to a large extent, the régime of the Saône, i.e. that of the northern rivers, with a winter maximum due to Atlantic rainfall.
3. The Valence basin section, in which the confluence of the Isère brings in the Alpine régime again to complicate matters, although less markedly than might be supposed. Here the Mediterranean influence begins to be felt.
4. The lower Rhône section, in which the Mediterranean influence gradually becomes dominant. The volume of the river is not greatly affected, but remarkably sudden rises and falls, due largely to Cévennes rivers, is characteristic.

Apart from irregularities of régime the Rhône is ill suited for navigation by modern craft. The main factor in this connexion is the velocity of the current which makes upstream transport almost impossible. The worst section is that below Givors in the basin of Valence. Above the narrows at Givors the steady influence of the Saône in the broad basin of Bresse makes possible a certain amount of traffic between Lyons and Chalon-sur-Saône. The formation of gravel banks frequently proves a serious hindrance to navigation. The Ardèche is again the sinner in this respect. If this stream comes down in spate without a corresponding flood in the main stream at the same time or shortly afterwards, a bar of gravel is formed above Pont St. Esprit which will interrupt navigation. This occurred in January 1927.¹ Again, banks are apt to form against any obstruction, and these are notably impeding to traffic at such places as the entrance to the lock which leads to the Beaucaire-Sète canal and at St. Louis du Rhône. Fog is perhaps an obstacle which we should not naturally expect in relation to Rhône navigation, nevertheless it occurs not infrequently during the winter months on both Rhône and Saône. For four or five days, for example, in December 1926 traffic was completely held up on the Saône by mist.

THE WATER WAY. M. Faucher² points out that the amount of traffic on the Rhône in the Middle Ages, which has formed the

¹ See *Navigation du Rhin*, January 1928, p. 21.

² See D. Faucher : *Le Rhône Moyen*, Paris 1927, pp. 389-90.

subject of much picturesque writing, has probably been greatly exaggerated. At a period when roads were non-existent or outrageously bad, waterways, however unregulated, were utilized as a *pis-aller*. Man-power was cheap and the goods to be carried—salt and wines—could afford the cost of transport. As far up as the great bridge at Pont St. Esprit, with its twenty arches using a number of islands in the river, there was doubtless much traffic, the gradient in the section between the head of the delta and this point being only 1/2500. Beyond this bridge, transport was mainly by road via the Ardèche valley to the upper Loire and Allier or via the enclave of Vaucluse to the Alpine routes or, skirting the eastern edge of the Rhône basins, to Tain l'Hermitage. The bulk of the traffic above Pont St. Esprit was probably downstream and carried on rafts or boats that could be broken up on reaching their destination, as on the Tigris to-day. Timber from the Isère valley and grain from La Bresse were the chief downstream commodities of transport in the Middle Ages. Salt formed the only important upstream freight and a duty on this article was levied for the upkeep of the bridge at Pont St. Esprit.¹

THE RHÔNE LANDS. The Rhône leaves Lake Geneva in the heart of the town of that name. On the outskirts of the town it receives the Arve. At Peney it flows at 1,180 feet above sea-level. Three miles farther down it forms the frontier between France and Switzerland. Near Pougny it is utilized for a hydro-electric plant generating 35,000 h.p. A few miles farther down it leaves Swiss territory to enter a remarkable gorge, the Défilé de l'Ecluse, which it has cut across the ridge of the Montagne de Vouache, one of the final ridges of the Jura. Two French national roads which skirt the enclave of French territory formed by the lake plain converge to traverse this gorge, as do the two French railway lines from St. Julien and Gex as well as the line from Geneva to Paris via Mâcon. One is not surprised to find at such a point of concentration a strong fortress, the Fort de l'Ecluse, guarding the defile. At Bellegarde the Rhône crosses another ridge, the small bourg standing at 1,200 feet upon the ridge. Below Bellegarde the river turns south, following a synclinal depression in the Jura. The Valserine enters here, following the same syncline, which here is faulted. In this section we have typical Jura scenery, the Rhône alternately cutting through the anticlinal ridges and following the deep, narrow, synclinal valleys in the limestone.² At the Etroit de Malpertuis the river swirls through a defile of only a few yards wide. At the Fort de

¹ See Faucher, op. cit., p. 392. The amount of traffic carried to-day is very small, though two companies employing very powerful tugs provide towage for barges, but may increase when regularization is carried out. See note p. 496.

² See Jura, p. 270.

l'Ecluse the gorge narrows again to fifty feet. At the Perte de Valserine and the Perte du Rhône at Lucey the karstic phenomenon of underground drainage is encountered, both the river and its tributary having carved underground channels; that of the Rhône has been unroofed in order to improve rafting conditions and to make possible the fixing of turbines to supply electricity for lighting and power. The turbulent river¹ is thus made to contribute to the economic development of the countryside. There are important pulping mills and phosphate factories to the north of Bellegarde. The high road avoids the gorges of the Rhône between Bellegarde and Seyssel, but the railway, by dint of tunnelling at intervals, is able to follow the river in its direct southward course. The pent-up stream supplies power at the electric stations of Génissiat, Seyssel, and at the confluence of the Fier. Génissiat is one of the most important power stations of France.

Between the Grand Colombier ridges and the Gros Foug the valley opens to form a marshy plain. The river has already begun to braid its course three miles above Seyssel, and though the fall is still about 1/100, great shingle banks appear. It now flows in the great synclinal depression between the Alps and Jura, occupied farther south by the Lac du Bourget,² with which it is connected by the canal de Savières. So level is the floor of this depression that the canal has no locks and the current is imperceptible. At Yenne it passes into the southernmost Jura folds, crossing by the Défilé de Pierre Chatel. Here a small derivation canal gives passage occasionally to the little flat-bottomed boats that, water permitting, navigate the Rhône above Lyons. At St. Genix it receives the Cuiers from the Alpine foreland, and, assuming the direction of its tributary, passes north-west across a broad plain of soft Tertiary rocks, in broad and meandering channels. It then narrows at Groslée to penetrate the Jura plateau, which it traverses for some fifteen miles, emerging finally from the mountains on to the Tertiary plain of the Ain in the neighbourhood of Lagnieu, having, in an extremely devious course, cut through the whole breadth of the Jura between Collange and that town (a distance of about thirty miles, and nearly double that by river).

The river, on emerging from the Jura, still hugs the limestone uplands—witness the village of La Balme-les-Grottes—for ten miles, until it turns west to join the Ain in the broad basin of Bresse. The braiding of the watercourses becomes more complicated; cut-offs and channels abound; the river sometimes

¹ Gradient of 1/40. A derivation canal takes off just above the *perte*.

² See p. 246.

spreads to lake-like widths and is dotted with reedy islands. Below Miribel the Rhône has suffered regulation. Its channels draw together and dykes hold its waters within bounds. The current, therefore, becomes swifter again. From now on the river passes through the succession of basins referred to above.¹

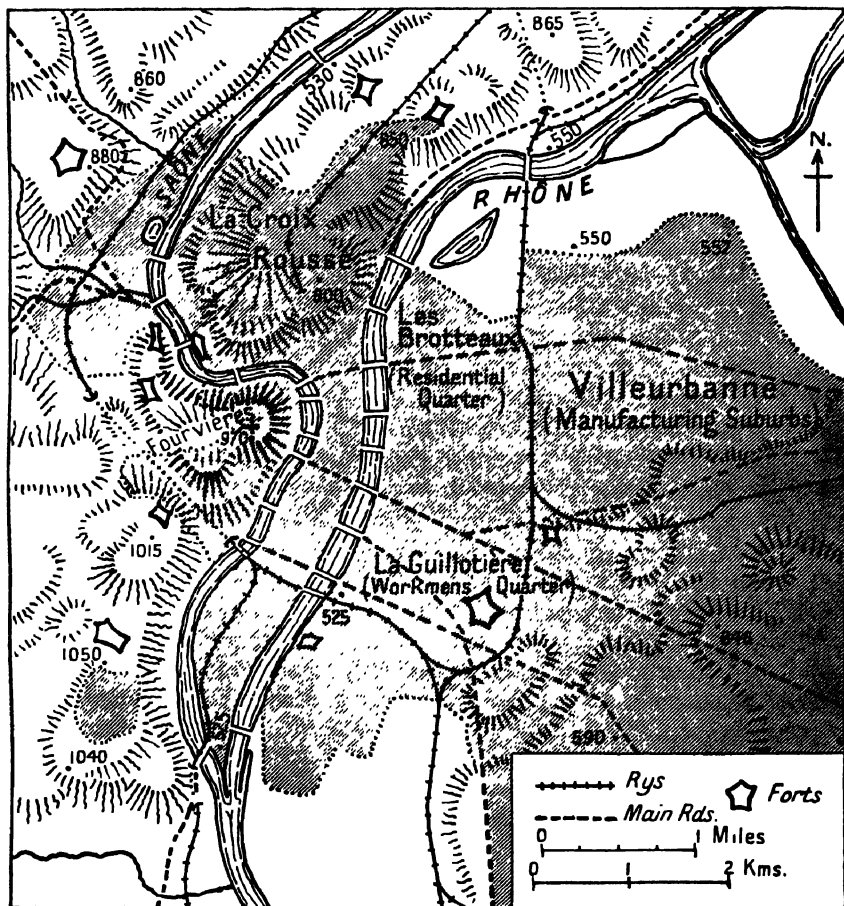


FIG. 54. THE CITY OF LYONS. NOTE THE LOW BLUFFS ON WHICH THE OLD TOWN STANDS.

LYONS. Lyons, at the confluence of the Saône, is essentially the product, first, of converging routes of the north and south passage-way; secondly, of the routes west via the St. Etienne gap to the Loire and east by the Rhône and Isère to Switzerland and Italy; and thirdly, of the bridges which cross the two great streams. Route nodality made inevitable the establishment of

¹ See p. 261.

a commercial centre at this point. Lyons was also the terminus of the Saône navigation and a place of transhipment for the more perilous navigation of the Rhône, both up and down stream.¹

The town is really an agglomeration of several settlements. The original Roman station appears to have been placed on the hill of Fourvières, a jutting spur of the *Monts du Lyonnais*, where the granite is covered with ancient alluvium, which rises some 300 feet in an angle of the Saône. This site commands the entrance of the Saône defile through the plateau of the Doubs. From the church of Notre Dame, which occupies the summit of the hill, one can look down over the old town, with its narrow streets and tall houses, which cover the steep slopes that drop to the Saône. A couple of funicular railways connect the town on the plateau with the town on the plain. The centre of Lyons to-day lies in the quarter-mile wide strip of land between the Saône and Rhône, and developed from the ancient bridge station guarding the Saône crossing. On the higher part of the spit of land between the two rivers, to the north, is the district of La Croix Rousse, with its crowded barrack-like blocks of flats rising in tiers one above the other. Here, in the earlier days of the development of the silk industry, dwelt the weavers who worked at home as the rural workers do to-day. Now handloom weaving is reserved for special materials and there are comparatively few in the town. Beyond the Rhône, which is crossed by twelve bridges and flanked by fine quays, lies the more modern quarter of La Guillotière, with the suburb of Les Brotteaux to the north of it, opposite to La Croix Rousse, and extending eastward for a couple of miles over the level plain of Bresse. It is a more recent addition, covering an area as great as the other districts put together. The two great rivers with their bridges and quays, and the hill of La Fourvière, redeem Lyons from dreariness. In spite of the great possibilities offered by its site, the town has neither the picturesqueness of the old walled feudal cities of France nor the elegance and spaciousness made possible by modern schemes of town planning. Yet it lacks the squalor of some of our own manufacturing towns. A dull air of prosperity pervades the place in spite of its endless rows of unrelieved house-fronts and its interminable narrow streets and tramlines. But Lyons has not the gaiety one might justifiably associate with the gateway of the Midi. Its population has grown rapidly, increasing by nearly 50 per cent in the last half century to 555,000 in 1936. The modern growth and prosperity of the town, the third largest in France, and a little larger than Sheffield, if only the town itself is considered, is based pre-eminently on the silk industry, which accounts for about four-fifths of the silk production of France.

¹ It was the eighth inland port of France in 1936. See pp. 493-4.

France consumes about 15 per cent of the world's production of raw silk,¹ and is only outpaced in production of silk goods by the United States of America. Manufactured silk is one of the chief export products of France,² and employs first and last a very large proportion of the industrial population of the country.

THE SILK INDUSTRY. The industry was started in the Middle Ages by Italian immigrants, and was supported by raw silk produced chiefly in Provence and Languedoc. For some time Lyons was the chief market of the world for raw silk. Of late years Milan has overhauled it, but it remains an important exchange.³ The industry only receives a small fraction of the raw silk it needs from the agriculturists of Provence and Languedoc, the rest being imported from Italy, the Levant, where important mills are owned by French industrialists, and the Far East. The growth of the industry has not resulted in a shifting to the coal-fields of the north or to one of the big ports; for that Lyons has to thank a situation on great international thoroughfares. The organization of the whole industry is centred at Lyons, though it spreads far and wide from that city. St. Etienne as we have seen, must be considered in a sense as an annexe of Lyons, and the valleys of the Jura and of the Alps are tributary also, both in the provision of spun silk and in the supply of labour, to say nothing of the supply of hydro-electric power (e.g. Champs on the Drac).⁴ Lyons is constantly making good her losses to such centres as Paris and Marseilles, by draining labour from the mountain regions to the east and west. The silk industry employs normally about 300,000 hands. It had been steadily growing in the years preceding the War in spite of the competition of Italy and the United States. The artificial silk industry has not become centred at Lyons, although it is manufactured at St. Chamond and Izieux in the St. Etienne district.

The interests of industrial Lyons are not confined to the silk industry. The chemical industry is naturally important in a large textile area. It was turned to account in the Great War for the manufacture of explosives. Large quantities of pharmaceutical and photographic chemicals are manufactured. In the leather industry Lyons is also a regional centre, with controlling interests in manufactures at Marseilles, Grenoble, Annonay and

¹ The U.S.A. consumes about 70 per cent.

² France exported 65,687 metric quintals of silk and rayon yarn in 1936.

³ France produced 6,738 metric quintals of cocoons in 1936 and imported 44,720 metric quintals of raw silk.

⁴ Cusset, on a derivation channel supplied by the Rhône and deriving power from a fall had the largest hydro-electric installation in the continent of Europe.

Romans. These minor centres at one time depended on local supplies of raw material, but now receive both material and orders from Lyons which collects and distributes hides and skins as well as manufacturing finished products.

Half a dozen miles below Lyons the Rhône leaves the plain of Bresse, which we associate with the Saône, to enter the passage between the Alps and Massif. This so-called 'corridor' consists of a series of enclosed plains—tectonic basins—separated from one another by ridges of hard rock, generally spurs of limestone, projecting from the foot-hills of the Alps. As it threads its way through them, the Rhône hugs the edge of the Central Massif, sometimes trenching a course into its hard rocks, sometimes following the foot of the escarpment, as in the basin of Roussillon. From Lyons to La Voulte below Valence ancient rocks composed of schists and granites form this edge, farther south the cretaceous limestones that flank the upland approach the banks of the river as the Cévennes curve away to the west.

THE RHÔNE PLAINS. The enclosed plains of the Rhône, which we have now to consider, are floored with great thicknesses of ancient alluvial gravels and other detritus which form terraces at varying altitudes, marking different stages in the evolution of the valley.¹ The terraces themselves are eroded into broken, undulating country by minor streams taking their rise in the edge of the foothills, and at long intervals are trenched by the great mountain tributaries from the Alps, the Isère, the Drac, and the Durance, whose broad, stony beds and braided streams form barriers nearly as serious as the ridges of limestone. The Rhône plains, lying between the fore-Alps and the Rhône valley, bear a variety of names. The *Valloire* plain lies north of the Isère, *Bayane* to the south of it. The plains of the lower Drôme are known as the *plain of Livron*. Then follow to the south the *plains of Montélimar* with the enclave of *Vauchuse*.

This zone of relatively low land following the Rhône corridor is, as M. Faucher abundantly shows,² a region of transition, in structure, in climate, economically and socially. Structurally it is a region of transition, because within it the north to south trend of the Mid-Tertiary Alpine folding gives place, by a zone of cross-graining, to the east and west trend of the earlier Pyrenean folds, which becomes marked south of the Drôme. This transition in structure is reflected in the relief. North of the Drôme the hills of Vercors run parallel with the Rhône, and are only

¹ It is on the slopes of one of these terraces that the Fourvière district of Lyons is built, and it was through an accumulation of water on the impermeable rocks beneath the relatively soft, sandy rock that the recent disastrous landslide occurred.

² See Faucher, *op. cit.*, p. 283.

notched into short spurs by the Rhôneward drainage. South of the Drôme the interference of Pyrenean and Alpine folding has had its effect in exposing to erosion the soft Cretaceous Clays in vales of east to west orientation between ridges of upstanding white limestone. The region marks also the transition from the domination of Jurassic limestones, which form high mountain barriers, to a region where the Cretaceous Clays form the dominating rock and the limestones make long, steep-edged ridges, capping the softer deposits. Let us now consider these plains in some detail.

THE PLAIN OF VIENNE. Between Givors and Vienne the Rhône crosses the sill of Primary and Jurassic rocks that separate the depression of Bresse from that of Valence. This sill it was that separated the lake basin of Bresse from the trench by which the waters penetrated from the Mediterranean. The river actually cuts into the promontory of crystalline schist in the syncline of St. Etienne, so that crystalline rocks appear on both banks from Saline to St. Clair. The affluent Gier, in its synclinal valley, and the Rhône valley itself, between Vienne and Condrieu, continued in that of the tributary Vega, mark the Hercynian graining emphasized by Tertiary folding. The Gier valley follows the line of north-eastward extension of the Hercynian coal basin of St. Etienne. Coal has been proved and worked to a small extent in the neighbourhood of *Givors*. The depression caused by Tertiary faulting and exposure of soft rock has made possible the straight valley-way of the Gier, which, by means of rail, road, and canal, brings St. Etienne into close touch with Lyons. The ancient canal de Givors, which at one time brought large quantities of coal to Lyons, has been decreed derelict since 1926, but the rail carries much traffic, and the valley of the Gier is a busy industrial district. *Rive de Gier* has important glass-works and, like *St. Chamond* on the water-parting between Rhône and Loire, combines the activities of iron and silk production. Its coal workings are exhausted. The small valleys, draining from the Mont Pelat to the Rhône, provide, with their streaming water-courses, power for the silk industry, whose local centre is at Pélussin. Givors also has glass-works and specializes in bottles. Of late years the somewhat decayed metallurgical industry of the Gier valley seems to have concentrated in its outlet at Givors, (where there are important coking-ovens,) probably on account of difficulties of transport and of labour scarcity in the upland. Vienne occupies the corresponding position on the eastward bend of the left bank of the Rhône to that of Givors on the westward bend and on the right bank. The river Cère collects a number of streams from the lake-studded uplands that separate the

marshy basin of the Bourbre in the north and the plain of Bièvre in the south.

Vienne, once a Gallo-Roman city of importance, commanded a convergence of Alpine roads on the crossing of the Rhône. Three valleys from the east, of which the most important is that of the Cère, converging on the bend of the Rhône at Vienne,

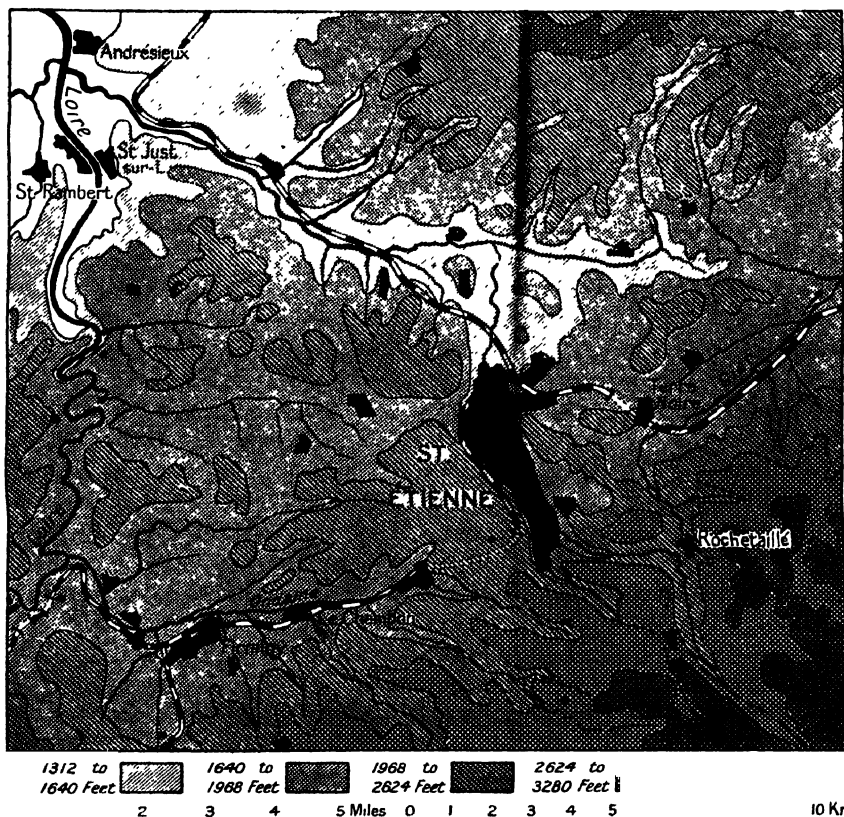


FIG. 55. MAP OF THE ST. ETIENNE INDUSTRIAL DISTRICT SHOWING THE HERCYNIAN TREND OF THE GIER AND ONDAINE COLLIERY VALLEYS. ST. ETIENNE LIES ON THE FURENS, TRIBUTARY OF THE LOIRE. RAILWAYS TUNNEL TO REACH THE GIER AND ONDAINE VALLEYS.

trench gorges through the barrier of crystalline schist which separates the Rhône valley from the more broken hill country lying to the east. The steep hills on either side of the entrance to the narrow Gier valley afforded protection, and the valley of the Gier and its tributary the Vega led to the Bourbre and so to the Rhône at St. Genix. It has lost in modern times

much of the significance of its natural nodality, owing to the dominating position of Lyons, the draining of the marshes of the Bourbre, which enables Lyons to communicate direct with Chambéry by rail, and the important line of communication from Valence via the Isère valley. Between the great town of Lyons, connecting with Grenoble by the drained valley of the Bourbre, and the town of Valence with its important low-level route to Grenoble via the Isère valley, Vienne has to-day but little economic nodality and serves the market of but a restricted area. It has a silk industry, subsidiary to Lyons, whose factories are situated on the flood-plain opposite the old town. The old Viennese cloth industry, now decayed, depended for its development on the water-power of the Gier in the narrow gorge at the north end of the town. A small woollen industry has survived. The remains of Roman fortifications, temples, aqueducts, and houses, however, point to its having had a considerable population in Roman times. It was the capital of the first kingdom of Burgundy and a powerful ecclesiastical centre.

The high alluvial terraces on the right of the Rhône are cultivated for the vine. Beyond, the industrial valleys are also cultivated or under pasture, as are the lower levels of the plateau. The higher slopes are forested with conifers and beeches which reach to the heath-covered summits.

THE PLAIN OF VALENCE. The Rhône now enters the great plain of Valence, a rolling country of alluvial terraces built up by the Rhône and the Isère. In the north the enclosed dry plain of Bièvre, continued towards the Rhône by the watery plain of Beaurepaire, appears to have afforded in earlier times a short-cut from the Isère to the Rhône. To-day the Isère enters the Rhône plain following a north-east south-west line of weakness along the edge of the Vercors. The upland between the two vales slopes gently from about 200 feet to the basin of *Bourg de Péage*, which is drained by the Isère on its way to the Rhône. This town specializes in making felt hats. Bridging was facilitated by a sill of hard rock which crops out among the soft detritus of the plain, and Romans can boast the earliest stone bridge over the Isère, which carried the Roman road to Lyons. The main life of the plain lies in the Rhône valley and in the valley of the Isère and the plain of Oron—the dominating factor being communication by rail with Lyons or Valence; for as we have seen, Lyons, directly or indirectly, draws on the labour of a very wide district. In the Rhône valley itself the population clings to the edge of the Central Massif on the right bank. Large villages and small market towns depend on the cultivation of the vine. Those to the north, where the influence of Lyons is strong, are steadily

increasing their population, but as far south as St. Vallier-sur-Rhône, St. Donat-en-Herbasse, Romans-sur-Isère, silk winding and weaving goes on for Lyons. The limy, sandy marl, of which the Tertiary rocks of the Fore-Alps are composed, give reasonably fertile conditions where the elevation is not too great—up to about 1,300 feet. In the Rhône valley itself the river flows swiftly between its white banks of shingle if the water is low, or sweeps over them in a mighty flood at high water. Poplars line the banks and divide the water-meadows of the flood-plain. Orchards and vineyards¹ occupy the higher ground. Long lines of mulberry trees follow the roads, broad fields of maize alternate with market-garden crops. Between St. Rambert and Vienne the national road and railway avoid the river banks, keeping a mile or two to the east. This is the main route from Marseilles to Lyons, and the population along it is distinctly more dense than on the opposite side of the Rhône. Large, modern annexes to the villages, such as Le Péage de Roussillon, with their cement and chemical works, dyeworks, and tanneries, and their long lines of new workmen's houses among the melon fields, orchards and vineyards, bespeak the proximity of Lyons. Annonay has important leather works. At the confluence of the Doux from the Massif, stands Tournon opposite the little town of Tain l'Hermitage. Here is a famous vintage. Industries based originally on local products have developed here, e.g. flour-milling and paste-making, furniture-making (the wood coming from the Isère), hosiery and clothing, straw hats made from the local straw, cardboard and cartons, machinery for agriculture and the textile industry. Artificial silk is manufactured at La Voulte, ten miles to the south on the right bank.

Valence is a flourishing town with a population of over 32,000. Besides being an important crossing-place on the Rhône, where roads from Le Puy, Gap, and Grenoble join the Rhône valley routes, it is the market centre of the fertile basin of Valence, with its *loess*-covered terraces, and for the wines of the Vivarais. Its excellent communications, its command of cheap labour, and the variety of the skilled labour available have led to the development of a great number of industries in its vicinity, among which are silk manufactures for the Lyons centre. Opposite to Valence a belt of Jurassic limestone accompanies the edge of the crystalline Massif of the Vivarais, giving warm, dry soils suitable to the production of the Vin Mousseux of St. Péray. The agricultural development of the plain of Valence is very ancient. Its characteristic feature is the variety of crops and methods in use, resulting

¹ Beaujolais, Mâconnais and Côtes du Rhône produce renowned wines. Sparkling wines are made at Chalon and Villefranche. Lyons wines preserve well, for they are rich in tannin and naturally acid.

from an age-long adaptation to the transitional nature of climate and soil in the plain of the middle Rhône. Drought has always been the main factor in determining the type of agriculture here. It has determined the types of wheat to be grown, eliminates the intensive cultivation of roots, makes necessary irrigation, and with it intensive cultivation of market-garden crops.¹

The uncertainty of the weather conditions in this transition area is also an important factor. The strong *mistral* blowing in the summer increases the effects of drought by increasing evaporation. In the winter the sudden cold makes the growing of delicate crops in other than sheltered conditions very hazardous. The drought is all the more serious because of the difficulty in the terrace regions of irrigation. Without expensive modern methods it is often impossible to get the water to the higher terraces, and in many instances the soil is too porous to make irrigation worth while.

The variety of soil has tended to encourage the growing of a number of different crops, and this tendency has been intensified by the uncertainty of climatic conditions, which makes the farmer fear to put all his eggs in one basket. The warm limestone soils of the Rhône slopes are well adapted to viticulture as also are some of the stony soils of the terraces. The calcareous sandy Tertiary subsoil is also suited to vineyards and orchards. The gravel terraces, where there is a sufficient covering of brick earth, are fertile enough and often grow wheat; if the brick earth covering is lacking the terraces are left to forest. The most fertile soils, and those most easily irrigated, are the soils of the flood-plain, and here we find intensive cultivation following a strip of land between the foot of the lowest terrace and the wetter meadow-land near the river. The mulberry does well here. It can stand a good deal of cold and it does not like moist conditions, so that the drying winds suit it and enable it to be grown even in the flood-plain. The potato stands the light, dry soils well, and for the last century has been a great asset to the countryside, making the fallow system less necessary.

THE GATE OF MONTÉLIMAR. Ten miles south of Valence the Rhône valley narrows suddenly. The basin of Valence is closed by south-west trending folds of limestone, which, continuing on the west of the river, form the upland of Vivarais. The limestone cliffs rise steeply above the river at Baix, and road and railway have to cut into the sheer rock. The hills behind Cruas rise to over 1,600 feet. On the eastern edge of the flood-plain the limestone hills rise nearly as steeply and are crowned by the dark forest of Marsanne. Though gorge-like in formation, this passage

¹ Faucher, *op. cit.*, p. 316.

of the Rhône between the plain of Valence and Montélimar is never less than a mile wide. It undoubtedly formed a barrier to communications at a period when roads were few and bad and when the river spread in flood-times uncontrolled over the plain. The uplands on either side were, and are still, sparsely populated, and the basaltic Massif of the Coiron, rising to 2,190 feet, is crossed by no road within eight miles of the river. The narrowing of the valley no doubt forms a barrier also as regards climatic conditions, but not a very definite one. Above the northern entrance to the gorge the Drôme enters, having crossed the southern extension of the Valence basin and entered the Rhône valley by trenching the northern edge of the Loriol limestone plateau in a gorge at Livron.

The southern extension of the basin of Valence is really a small, separate tectonic basin let down in the Tertiary rocks. The Drôme enters it at Crest.

West of the Rhône, Privas is the centre of an upland sericultural district, enclosed to the south by the Coirons, whose basaltic rocks reach the Rhône at Rochemaure. A light railway links Privas with the textile district of Ardèche.

THE PLAIN OF MONTÉLIMAR. On emerging from the gorge of Cruas, in which its course is very steep and rapid, for there is a definite break in the gradient, the Rhône enters the basin of Montélimar. Here the evidence of Provençal climatic conditions becomes marked, particularly on the right bank. 'La Provence est née sur la rive ardéchoise, longtemps avant qu'elle n'apparaisse triomphant à l'est du fleuve.'¹ The river continues to hug the edge of the Central Massif and leaves a broad alluvial plain on its left bank. This plain it shares with the Roubion, which, like the Drôme, waters an ancient alluvial basin before entering the main valley by a gorge—this time trenched through the Tertiary limestone hills, which rise to 500 feet on either side of the exit, above the town of Montélimar. The Roubion basin, of which Bonlieu is the centre, is surrounded by forested hills on whose lower slopes the population of the district is collected in a number of villages. Marsanne is the centre of the canton.

Montélimar lies at the entry of the Roubion and its tributary the Jabron on to the plain. It stands on an alluvial terrace at about 250 feet above sea-level, and is a busy country town of 13,800 people. The old fortified city has a commanding position at the junction of the Roubion and Rhône routes. The Rhône terraces here are composed of infertile gravels, so that the population avoids the plains and clings to the edge of the upland. Here and there, in sheltered places, especially on the right bank, the

¹ Faucher, *op. cit.*, p. 64.

olive may be seen, heralding the approach to Provence. The land to the south and west of Montélimar is almost devoid of inhabitants.

At Viviers, at the confluence of the Escoutay from the Cévennes, the Rhône enters a narrow gorge about three miles long known as the *Robinet de Donzère* from the village of that name at its southern exit. The gorge is due to the obstruction offered to the river by a sill of hard limestone. The watercourse narrows just below the town, so that the right bank railway leaves the river and tunnels through the hills. The road is also forced to leave the river at this point. From this gorge the Rhône emerges on to the plains of Provence.

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CHAPTER X

THE MEDITERRANEAN REGION

UNDER the above heading we group those regions whose main characteristics are determined by the climatic conditions of the Mediterranean basin. They present great variety of structure and relief, for they include the southern slopes of the Central Massif, the eastern extremities of the Pyrenean folds and their extension in the folds of the Petites Alpes of Provence, the maritime portion of the High Alps, the Massifs of the Maures and Esterel and the isolated mass of Corsica ; finally the great alluvial delta of the Rhône and Durance and the plain of Roussillon.

The Pyrenean section, including Roussillon, we have already dealt with in Chapter VI. *Bas Languedoc* comprises the land that lies west of the Rhône, between the gulf of the Lion and the Cévennes edge of the Central Massif, and is drained by the rivers Gard, Vidourle, Hérault, Orb, and Aude. It remains a region somewhat apart, looking towards Perpignan and Sète (Cette) rather than to Marseilles and the Rhône valley. The high edge of the Cévennes cuts it off from communication with the north. The flat, coastal plain prevents it from becoming a tourist resort. Its silted shores preclude the development of large ports. It remains therefore an agricultural area of a rather poor type and somewhat limited interests.

Provence, an area of very diverse geographical conditions, is united by the relation of its various parts to the Rhône corridor and Marseilles. It includes a number of sub-regions :

1. The High Alps and the Low Alps, drained to the Rhône by the Durance and its tributaries and direct to the Mediterranean by the Var.
2. The Rhône funnel, with the Camargue and Crau, drained by the lower Rhône and Durance. (The northern portion of this sub-region has been described in Chapter IX.)
3. The Hercynian Massifs of the Maures and Esterel and the island of Corsica.
4. The Triassic basin of the Argens, shut off from the coast by the Maures and Esterel uplands.

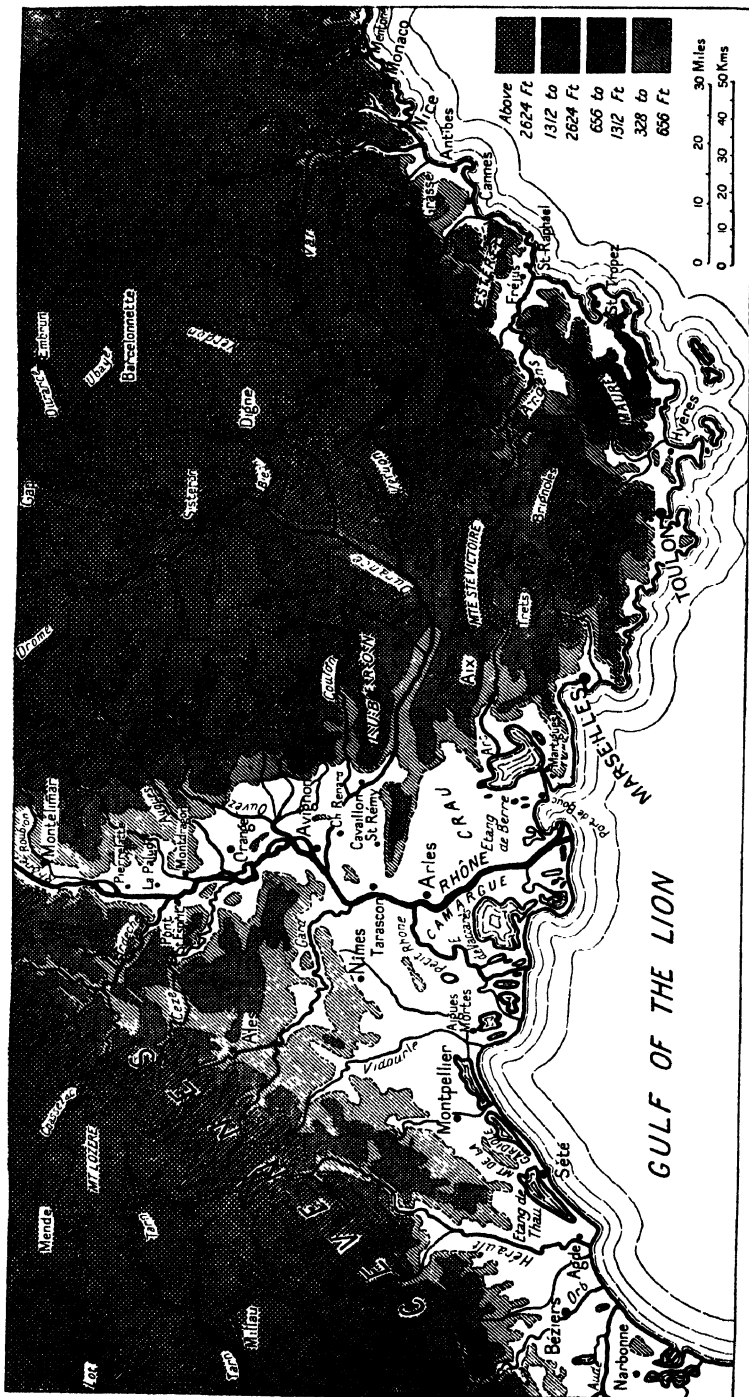


FIG. 56. PROVENCE AND BAS LANGUEDOC

PROVENCE

In the foregoing chapter we carried our study of the Rhône valley to the *Robinet de Donzère*, which is usually considered as being the dividing line between southern and northern climatic influences, although, as M. Faucher remarks,¹ the *Porte de la Provence* is really a zone. On emerging from the Robinet de Donzère the Rhône enters definitely the Mediterranean region. Indications of Mediterranean influences are now no longer sporadic. After traversing the transition region of Valentinois we are *en plein Midi*. The traveller from the north who enters Provence by way of the Rhône valley has been gradually accustomed to the establishment, one after another, of the characteristics of the Midi. The recession of the beech tree into the mountain, the increasing frequency of the mulberry groves, of strips of irrigated land, of patches of olive trees on sheltered slopes, the clearer skies and persistent dry north wind, the evidence of summer drought, the flattish, red-tiled roofs, the narrow, shady streets—all become familiar. But if he enter the Midi from the Cévennes, by the Chassezac valley, for example, he passes suddenly from scenery and climatic conditions that recall the highlands of Scotland—peat-bog and heather, granite rock and rushing burn, bracken and bilberry, perchance rain and mist—he passes from these to blazing sunshine, blinding white roads, bare, dazzling white limestone scarps, parched hill slopes with scanty covering of dark *garrigue*, to the wispy greyish-blue of the drought herbage with its strong, aromatic scents and the everlasting chirruping of the crickets. He is suddenly in a strange land.

The geographical factor that characterizes the life and controls the activities of the Midi is the unfailing and prolonged drought of the summer. The lack of rain combined with the great heat, the high evaporation increased by the prevalence of the *mistral*, and the porous limestone soil, makes it impossible for other than drought-resisting vegetation to survive except where irrigation is practised. The low-lying alluvial soils of the river plains are periodically irrigated by nature, and the reclamation of some of these lands has increased the area capable of producing non-drought-proof vegetation. Deforestation, on the other hand, has doubtless added to the arid regions by increasing the rapidity of the run-off from the soil and by taking away the shelter essential to protect the development of undergrowth. This deforestation, which has been continuous since Gallo-Roman times, has particularly affected the Rhône terraces.

¹ D. Faucher : *Plaines et Bassins du Rhône Moyen*, p. 63

Let us now follow the Rhône as it makes its way to the sea through the plains of the Comtat and Provence.

THE BASIN OF PIERRELATTE. On emerging from the Robinet de Donzère the Rhône enters the once marshy basin of Pierrelatte, about twelve miles long and four to five miles wide, with the village of La Palud as its centre. It is very similar to the basin of Montélimar, having a broad plain traversed by a number of indeterminate channels. This basin, owing to the fertility of its alluvial floor, was drained and occupied early. The Ardèche, entering it on the south-west, has built up a small plain on the right bank of the Rhône also. The ancient villages whose inhabitants draw their livelihood from the plain lie on the sloping edge of the basin. The more important settlements lie at the entry of valley routes from the upland.

The natural irrigation of the low-lying terraces explains the early settlement of the flood-plains, in spite of marsh fever and danger from floods. To-day the inhabitants avoid the flood-plain, which is given up to meadows and market-gardening, and have migrated to the *limon*-covered terraces, particularly those to the west of the Rhône, which are sheltered from the north. The more exposed terraces east of the Rhône are largely covered with *garrigue* of Kermes oak and box, useful mainly for firewood and charcoal burning and the production of tanning bark. Except in the west, where the highland approaches the river, the river plains become more and more deserted as the alluvial land increases in area and the population clings to the valley slopes, where little towns of one or two thousand inhabitants are connected by the road and rail which skirt the flood-plains of Rhône and Durance.

The river continues to hug the edge of the Massif. Tributary streams, rising in the edge of the basin, flow parallel with it for considerable stretches before joining the main current. Road and railway on the east take a median course through the basin on the edge of the terrace of gravel which overlooks the plain of recent alluvium. The Berre tributary gives access by its valley to the Enclave of Vaucluse, a small tectonic basin six miles by twelve, which occurs where the east to west Pyrenean folding comes into conflict with the north to south trend of the Alps and the Hercynian south-west trending folds that cross the Rhône.

Just above Pont St. Esprit, near the southern extremity of the basin, the Ardèche reaches the Rhône through a bay of lowland which it traverses after emerging from the long, winding gorge by which it crosses the limestone rim of the Central Massif. Pont St. Esprit stands on the terrace that accompanies the south bank of the Ardèche and commands the crossing of the Rhône

and the roads to the upper Loire and Lyons. From now onwards Cretaceous limestone ridges stretch east and west athwart the course of the Rhône. The river trenches these obstacles one after another, now in a wide passage, as at the defile of Montdragon, now in a narrower one as at Rocquemaure. One such ridge separates the Rhône plain of Avignon from the region of the *Paluds*. Between the ridges lie basins filled with ancient and recent alluvium.

At Montdragon, at the southern extremity of the plain of Pierrelatte, the plain narrows to a passage again, cuts through the rocks of Cretaceous limestone, and the Rhône enters the *plain of Orange* with its succession of terraces trenched by the river Aygues. Orange stands at the foot of an isolated mound of limestone and is nearly encircled by the river Meyne. It has a commanding position apart from its local defensive site, controlling as it does a fan of Alpine routes from the direction of Gap, Briançon, and Nice, which converge on the Rhône at this point.

The Rhône is now flowing well above the flood-plain. The number of marshy areas, *paluds*, increases. It frequently divides, its arms embracing long, marshy islands. Unfortunately the pasture in these water-meadows is poor and, as a result, the cattle are few. The olive is now universally cultivated on the lower terraces. On the drier terraces the almond tree has become a conspicuous feature. It requires no irrigation and little attention of any sort, but cannot stand spring frosts, and the frequency of its occurrence is, like that of the olive, a sign of predominant Mediterranean influences. Walnut and chestnut trees now appear in the fields and hedges. Vineyards cover all the lower sunny slopes and descend into the plain.

From Pont St. Esprit downwards the river forms a succession of islands of which one of the largest, the Isle de la Barthelasse, lies to the north of *Avignon*. Probably the deciding factor in the situation of this town was a small outcrop of limestone rock rising out of the alluvium on the brink of the Rhône—the *Rocher de Doms*. It is a spur of the limestone ridge which accompanies the river on the Villeneuve side and which the Rhône has isolated. Its eroded edge forms a rampart above the water and commands the old bridge. Massive walls continue this natural fortification. The Cathedral and the Palais des Papes are built on and into the solid rock. Avignon has scarcely emerged from the confining walls of medieval times, but a narrow belt of population follows the walls on the south side and extends for a short distance along the roads to Tarascon and Aix-en-Provence, and the open spaces within the walls have been largely built upon within the last

fifty years. In the surrounding country irrigated market-gardens support a large population. Villeneuve-les-Avignon, on the opposite side of the Rhône, also occupies a strong position. It lies on a section of the wooded upland that forms the most southeasterly projection of the Central Massif, detached from the main hills by the now drained swamp of Pujaut. It was a border fortress of the kings of France when Avignon was in the hands of the Popes.

Three miles below Avignon the Durance joins the Rhône. On the opposite side the Gard, or Gardon, emerging from the Central Massif at Alès (Alais), traverses the bordering region of limestone hills whose average level is about 700 feet above the sea. Its tributary, the Alzon, drains the fertile basin of Uzès, covered with small villages and hamlets, where cereals, lucerne and sugar-beet alternate with olive groves. The clays of the basin floor are used for pottery fabrication. The Gard avoids the basin and makes its way through a series of gorges across the wooded plateau to the south. Near the point where it emerges from the upland, its valley is spanned by the famous aqueduct, now coupled with a bridge, and known as the Pont du Gard, by which the Romans supplied the town of Nîmes with water.

We are now in the department of Bouches du Rhône, but the delta does not begin yet. The alternation of bare limestone ridge and clay-floored basin continues on the eastern side of the Rhône until the shores of the Mediterranean are reached. The arid hills and plateaux stand in sharp contrast to the strips of irrigated fertility. Water, and shelter from the *mistral* are the essentials for intensive cultivation. Accordingly we find the lower levels in the lee of the hills covered with market gardens irrigated by the Crillon canal, which brings water from the Durance. The deep-rooting vine grows on the stony slopes and cherry and peach orchards also cover large areas. Rows of poplars act as wind-breaks, and screens made of reeds shelter the more delicate plants. Aramon, on the right bank of the Rhône, is surrounded by gardens which specialize in seed production. St. Rémy also specializes in seeds and stands first in the district for the production of *primeurs*.

Avignon is the market for this extensive but broken area of intensive cultivation. The growing of *primeurs* extends to the opposite side of the Rhône and is important in the neighbourhood of Cavaillon and Châteaurenard. The former specializes in the production of early melons, the latter in peas, potatoes, and artichokes. Châteaurenard is the chief collecting and expediting centre for the *primeur* industry ; it not only augments the supplies of Avignon and the surrounding district, but it is the most

important station for the dispatch of perishable goods by express train.¹

A dozen miles below the mouth of the Durance, Beaucaire and Tarascon face one another across the river. The former marks the entrance of the Rhône-Sète canal. These small towns lie in a narrowing of the valley where the meandering streams draw together between the arid limestone hills and make bridging possible. A great suspension bridge crosses the river here. The once famous fair of Beaucaire has dwindled to nothing owing to lack of good, modern means of communication; for there is next to no traffic on the Rhône, and the canal du Midi is quite inadequate for modern transport.

THE PLAINS OF THE RHÔNE DELTA

CRAU. South of the Chaîne des Alpilles, with its fantastic forms of uncompromising white limestone and its skimpy vegetation of evergreen oak and aromatic herbs, contrasting strongly with the irrigated plains, lies Crau, once a stony waste covered with the coarse detritus brought down in past ages by a former course of the Durance. The canal des Alpilles (or Alpines) and the canal de Craponne to-day have redeemed much of this dreary land and converted it into gardens. *Salon de Provence*, on the edge of the Crau, is the centre of a large vegetable oil industry based on local grown olives. Sesamum oil is used together with other vegetable oils to cut the pure olive oil, which apparently has too strong a flavour for the modern palate.² The manufacture of the oil is scattered in the villages and hamlets all over Provence, except in the High Alps, and there are a number of modern factories. The industry employs altogether about 10,000 persons. Olive oils from Spain, North Africa, and Italy are also treated and blended. A number of industries are dependent on the cultivation of the olive. Of these one of the largest is the preserving of olives, which is carried on chiefly in the department of Gard, where some 500 persons are employed during the season. The olive is not ready for gathering for the extraction of oil until the winter months when the fruit has lost some of its moisture and the oil has concentrated, but for

¹ Export of *primeurs* according to season. October: cauliflowers and salads. November to February: leeks, spinach, parsley, radish. March and April: cauliflowers, lettuce, early asparagus, spring onions. May: early potatoes and peas, cherries. June: beans, apricots, peaches. July: tomatoes and aubergines. August and September: grapes and fruit (M. A. Meglé, *Marseille*, 1926).

² In 1936 France produced 4,800 tons of olive oil. This was a drop of 60 per cent compared with 1928.

purposes of preservation it is gathered in October and November. As at Marseilles, soap-works at Salon depend on the oil industry.

Unfortunately the supply of water to Crau from the Durance is both limited and unreliable, and the porosity of the subsoil makes it doubtful if much further expenditure in irrigation would be worth while. According to D. Faucher,¹ the further development of the agriculture of Provence is to be looked for in the selection of drought-resisting species. Wheat and root crops have been introduced successfully, and the cultivation of fodder crops of the leguminous type which are specially adapted for resisting drought—lucerne is the most important—is a modern development.

Apart from the relatively small area that comes under the beneficent influence of the Durance irrigation, Crau is merely a waste of river-worn stones, which, however, is able to support, by its aromatic drought-herbage and the grass that grows between the stones, large flocks of sheep during the cooler months of the year, after the autumn rains begin. In the grilling summer season they have to be removed to the mountains.² Reafforestation of the Alps has led to a diminution of this *transhumance*. The improved irrigation and the introduction of lucerne as a crop have both benefited the sheep-rearing industry. Hay and sanfoin are also produced under irrigation. Some areas, however, are too arid even for sheep feeding in the autumn and spring, and produce only *maquis* scrub and rabbits.³ Towards the west of this ancient delta land of the Durance the land becomes more marshy. The population is limited to the edges of the plain of Crau except in the better irrigated eastern part. The little settlements south of the Alpilles chain derived a certain prosperity from the exploitation of bauxite (hydroxide of aluminium), which occurs in the Lower Cretaceous rocks, where they have been exposed to continental disintegration along a line of emergence which, during Upper Cretaceous times, stretched between the Central Massif and the Maures and Esterel block.⁴ The tiny village of Les Baux, south-east of Tarascon, in Bouches du Rhône, gave its name to the red clay rich in alumina which is found on the flanks of the limestone hills, but the exploitation of this ore is now mainly carried on in the basin of Brignoles in Var, and only small quantities are mined at St. Rémy-les-Baux. The decay of Baux, the curiously constructed troglodytic stronghold of the Middle Ages, is due to its position on a platform jutting from the Alpilles and away from any through road.

¹ Op. cit. pp. 485-6.

² See p. 402 on *transhumance* to the Alps.

³ M. Peyre: 'Les irrigations de la Basse Durance' (*A. de G.*, 1927, p. 40).

⁴ See M. Gignoux: *Géologie Stratigraphique*, p. 381.

CAMARGUE. The Camargue is the Rhône delta proper. The Rhône drives its waters through the mass of sand that it has accumulated by two distributaries, the Grand and the Petit Rhône. The Grand Rhône, owing to its greater carrying power, for it takes about 86 per cent of the water and silt, has built out its section of the delta much farther than the Petit Rhône. The more recent part of the delta is composed largely of marsh and lagoon, with a few scattered clumps of trees on the firmer ground. The older and higher parts have a few inhabitants, herdsmen and shepherds for the most part, but malaria has been a great deterrent to settlement. Sportsmen visit the marshes and lagoons to shoot duck and snipe. Apart from this the Camargue is a great solitude. Its vast sheets of water, such as the Etang de Vaccarès, are surrounded by tall reeds which harbour wild duck and other fowl; herons and storks fish along its shores which are visited also by flamingo and ibis, like the Nile marshes. Something approaching 75,000 acres is the area of the delta built out by the Rhône in historic times.

Arles, at the head of the delta, is now over twenty-eight miles from the sea, but it was in Roman times the chief port of the Rhône corridor; only, instead of basing its maritime trade, like Marseilles, on a rock harbour, it was a kind of Venice, controlling an island-studded lagoon. The great bridge which carried the Roman road (Via Aurelia) across the river formed a vital link in the chain of communication that joined Rome with Cadiz and made Arles the most important centre in southern Gaul. The Roman city lay on the south bank at a bend in the river, and the relatively high bank was further protected by ramparts. The great amphitheatre and the ancient cemetery are evidence of the large population that once lived within the walls, and in the suburb of Trinquetaille on the opposite side of the river. Arles was the great grain mart of southern Gaul. In medieval times Aigues Mortes was an important port on a marine channel that opened westward to the Mediterranean. This distributary is now completely silted up, but an old shoreline is distinguishable running from Aigues Mortes along the northern edge of the Etang de Vaccarès.¹ Deposition is proceeding more rapidly to-day as a result of embanking, and the delta is working eastward as the river silts up the exits of its own western distributaries. The town was built on territory acquired from an earlier abbey, whose monks had done much to reclaim the salt marshes.

The Camargue is gradually being reclaimed and converted

¹L. de Launay, op. cit., p. 480. See also R. D. Oldham: 'The Portalan Maps of the Rhône Delta' (*G.J.*, May 1925), for a discussion on the development of the Rhône Delta.

from a desert of salt marsh, capable only of feeding herds of half-wild cattle and horses and flocks of sheep,¹ to a region of good pasturage. Drainage and irrigation combined have effected this, and the obstacles to improvement presented by the salt efflorescence and the brackish nature of the water are overcome by spreading the river silt over the land. The work is only gradually being carried out, however, for labour is scarce and the supply has to be augmented by imported labour from Spain and Italy. Reeds from Camargue are used for making cellulose. The main income of the district is derived from salt procured by natural evaporation in the summer, and distributed coast-wise by a regulated marine channel, and from fishing. The Salin de Giraud, west of the Great Rhône delta, has salt-works.²

BAS LANGUEDOC

The alluvial plain continues from the Rhône delta westwards, narrowing steadily as far as the neighbourhood of Sète. This plain has been built up of silt carried westward from the mouth of the Rhône by the marine currents which sweep along the shore of the gulf of the Lion. Behind the sand-spits that form the smooth coastline the lagoons are strung out, forming an amphibious area continuous with the delta. Salt, fish, and wild-fowl are the products. Behind this zone again the low ridges of folded Tertiary limestone hills exhibit the trend of the Pyrenean folding. They differ little from the hills to the east of the delta, and, like them, are covered with drought vegetation. They are usually referred to as the '*Garrigues*'. The valleys cut deep into this upland and, where irrigation is possible, are fertile. The vine is the main product of agriculture. It is cultivated particularly on the lower terraces of limestone and the still lower terraces of sand and gravel that constitute the former shoreline.

The city of *Nîmes* occupies an interesting position, geographically, on the edge of this hill country. The bluffs of the *coustière*, as the limestone brink is called, overlook the town, with the Mont Cavalier, which bears the Tour Magne, a Roman tower, possibly related to the Roman fortifications. From the foot of the scarp a spring emerges which at times sends a great flow of water through the Roman baths which lie below the hill and which date from the time of Augustus. The reservoir of the Pont du Gard aqueduct³ is also placed upon the slope of the

¹ The department of Bouches du Rhône has more sheep than any other Provençal department.

² See Chap. XIV on Communications, p. 490.

³ p. 302.

coustière. The Gallic town was created a military colony by Augustus. Agrippa developed and beautified the city, which acquired great prosperity as a strong point and trading place connected with the Roman seaports of the gulf of the Lion. Its glory departed with the arrival of the Goths, and the medieval city occupied only the centre of the space enclosed by the Roman ramparts. Later, Italian immigrants introduced a silk textile industry and the town enjoyed a new prosperity. The Protestant religion took a great hold in the place, which fact may account for its development as an industrial centre until the Revocation of the Edict of Nantes. The discovery of the coal-field of Alès, in the department of Gard, has helped its industrial revival in modern times, and a large number of small industries flourish there to-day, including woollen and silk textiles, foundries, tanning works, and calico printing works. It is, however, as one of the chief centres of the wine industry that Nîmes is important to-day. Whereas the population of Arles has steadily diminished during the last half century, that of Nîmes has risen from 60,000 in 1866 to 87,377 in 1936.

Montpellier is the wine centre for the Hérault department, which produces a greater amount of wine than any other department in France, although it was not until the eighteenth century that the vine became the chief object of cultivation. The town lies on a mound above the level plain. Between Montpellier and Sète (Cette) the Montagnes de la Gardiole form a steep-edged ridge of limestone very similar to those overlooking the basin of Aix-en-Provence. At the end of it a rocky island of limestone has formed the base on which the coastal currents have built up the long sand-spits that enclose the lagoon of the Etang de Thau, which has a navigable depth of eight feet and which separates Sète (Cette) from the mainland. The town is built partly on the slopes of the Mont St. Clair and partly on the sand-spit. It extends along the latter beside the Montpellier road. A canal connected with a number of basins gives access from the lagoon to the artificial harbour on the Mediterranean which is protected by moles. A number of industries have sprung up on the shores of the Etang de Thau—wine and liqueur factories, barrel factories for which wood is imported from U.S.A., petrol refineries, repair factories for railway rolling stock, and others; but the industrial development is small as yet. With the various extractive industries of the hinterland—iron, bauxite, lignite,¹ and salt—there would seem to be possibilities of development, given improved communications. The port has benefited by harbour

¹ Small quantities of lignite are mined in the Tertiary basins of Alès and Uzès.

works carried out during the Great War, and also, like Nîmes and Montpellier, from the recrudescence of the vine cultivation. It imports nitrates for the vineyards, phosphates, and pyrites, and is connected by canal with Bordeaux and with the Rhône by a canal which passes through the lagoons.

To the west of Sète the basalt hills of the Hérault basin are covered with vineyards. The line of volcanic activity noted on p. 29 is continued to the coast at Agde, at the bridge over the Hérault, which is built entirely of dark lava stone. Between the town and the coast the Pic de St. Loup is an extinct volcano, once an island which the drifting alluvium has joined to the mainland. Its slopes are all under the vine. The occurrence of this mass of resistant rock accounts for the break in the smooth line of the coast. Behind the *coustières* the land rises rapidly, forming a kind of amphitheatre in Lodève, where the basalt rocks appear among the Jurassic limestones along the volcanic line Espalion-Agde, in Escandorgue. The lower Hérault and Orb valleys are irrigated and the cultivation of the vine dominates all other utilization of the land. From the mouth of the Aude southwards the upland country, composed of Tertiary and Cretaceous rocks, reaches to the sea, forming the little upland of Clape, probably a truncated portion of a Pyrenean fold. Narbonne, south of the *coustière* overlooking the Aude, lies near that point in the coast where the direction becomes north and south in sympathy with the great coal furrow fracture of the Central Massif.¹ The north and south route from the Col de Perthus into Bas Languedoc and the west and east route from the Garonne via Carcassonne, '*la grande voie historique*', cross at Narbonne.

EASTERN PROVENCE

South of the Durance the Arc valley drains a series of basins in the Cretaceous and Tertiary limestone. South of the basin of Trets in the Cretaceous limestone hills are lignite deposits which are mined to a depth of 800 feet at Trets, Peynier, Fuveau, and Créasque. North of this basin rise the great palisades of the Montagne du Cengle, and above, and beyond them, the sharp-cut edge of the Montagne de Ste. Victoire. The Arc passes through a gorge in the limestone to enter the basin of Aix, and finally crosses an alluvial plain which forms part of the drowned rock basin of the Etang de Berre.

MARSEILLES. Marseilles is not happily placed to be the outlet of the Rhône passage-way. Yet, when we come to

¹ De Launay, op. cit., p. 477. See also Fig. 12, Geological map of the Central Massif, and Fig. 77, showing the distribution of wine production.

examine the conditions provided by Nature for the emplacement of a port at the entrance of the Rhône valley, we have to admit that the site is as well chosen as could be. It is obvious that no large town could exist lower downstream than Arles, and even a superficial study of the river conditions at Arles shows the impossibility of establishing a modern seaport there. No amount of regularization could control the shifting banks and bed of the river, nor ensure a depth necessary for seagoing vessels over the ever re-forming bar. The whole coast from Sète to the Rhône delta is silted by the westward-flowing currents that,

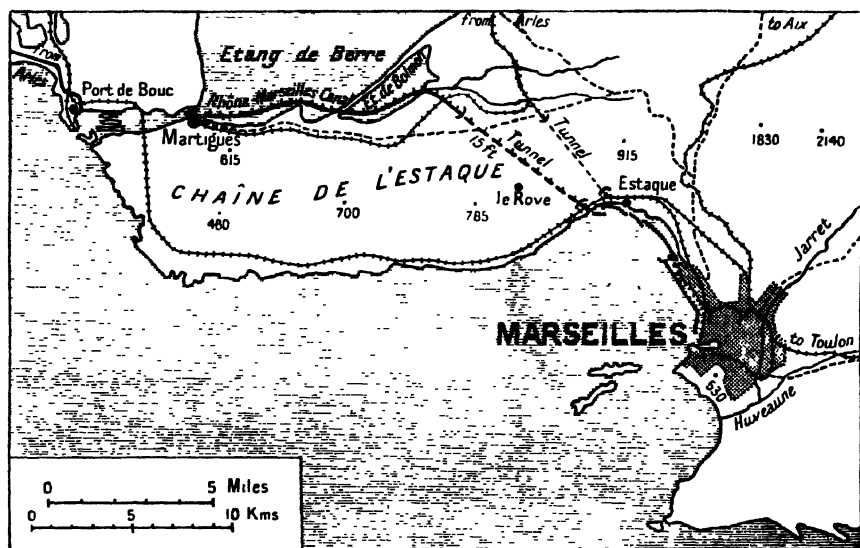


FIG. 57. MARSEILLES

driven by the south-east winds, prevail along these coasts. Land building has been continuous throughout historic times. Only to the east, where the low limestone hills that continue the Pyrenean system approach the coast, is there freedom from silting and shelter from the stormy winds of the gulf of the Lion.

The town owes its site to the presence of a small rock basin,¹ part of a drowned winding creek which opens north-westward to the bay of Estaque, the north-east corner of the gulf of the Lion, protected by a group of islands. Here Massilia was founded by

¹ In a very similar position, some fifteen miles to the south-east, there was another Greek settlement called Tauroentum, long since vanished.

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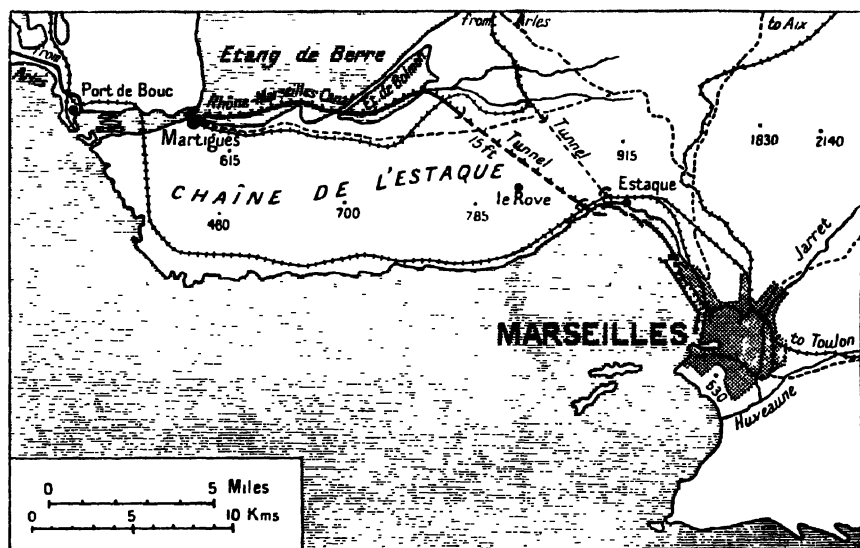


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Greek traders from Asia Minor about 600 B.C.,¹ at a time when the Mediterranean was already a great highway; but the Rhône valley was obstructed by marsh and swamp and by dangerous tribes. The name Massilia comes from a Phœnician word meaning settlement. The port may early have become a centre for the distribution of Mediterranean wines to the Celtic regions to the north, though there is little evidence of the utilization of the valley as a trade route between Orange and Lyons before Roman times. Gallic traffic passed up the river to Pont St. Esprit, whence a trans-Cévennes route crossed to the Allier. The port grew in importance as the construction of roads proceeded with the north-westward extension of the Roman empire. But the great east to west road ran from Fréjus to Arles, via Aix, avoiding Marseilles. At the fall of the Roman empire, Marseilles lost much of her importance as the gate to the north-west. Insecurity to life and property was such that 'Marseille elle-même n'y put faire pénétrer ses courants commerciaux'.² Italy, through the early part of the Middle Ages, carried the bulk of the Mediterranean traffic to the north and west via the Alpine passes, and even France was reached through Italian ports and the Alps.

The modern port was made necessary by the development of the African colonies, of which Marseilles has always regarded itself as the metropolis and patron, and by the cutting of the Suez Canal, which revived the trade with the Far East. Genoa, with the Alpine passes behind it, was a rival of Marseilles throughout the Middle Ages, and this rivalry became very serious again with the cutting first of the St. Gotthard and later of the Simplon tunnels, whose railways tapped the traffic previously forced through the Rhône corridor. Marseilles is not well placed locally from the point of view of inland communication. Roads, railways, and canals have a serious obstacle to cross in the Chaîne d'Eguilles, the Raumartin ridge, and, worst of all, the steep-sided chain of Estaque, 850 feet high, not to mention the barrier provided by the Rhône delta with the Etang de Berre.

Modern Marseilles³ occupies a great part of the floor of a Tertiary (Oligocene) lake basin, which was depressed between two ridges of Cretaceous rocks. The basin was drained out and dissected by a stream which flowed westwards to the gulf of the Lion and whose lower submerged course now forms the old rock harbour of Marseilles. The waters from the rim of the basin are

¹ 'The Greeks had established contact with that region during the half century preceding the traditional date of the colony's foundation.' J. M. de Navarre: 'Massilia and Early Celtic Culture,' *Antiquity*, p. 422, December 1928.

² D. Faucher, *op. cit.*, p. 199.

³ With a population of 894,000 in 1936, it was the second city in France.

collected by the Jarra, now a tributary of the Huveaune. The latter enters the basin in the south-east and cuts through its western rim between Le Roucas Blanc and the Chafne de St. Cyd. The Jarra probably drained at one time into the drowned creek which formed the original harbour along the line of the ancient ropewalk—the Cannebière. The old town lay around the harbour and on the slope. To-day Marseilles is widely spread—all the lower ground is packed with grey houses and buildings and the lower slopes of the sides of the basin are dotted closely with white villas, the houses of the market-gardeners and weekend shelters. Along the northern edge of the basin the canal de Roquefavour brings water from the Durance to irrigate the market-gardens and orchards of apricots and to supply the domestic needs of the town. Olive groves and mulberry trees give a wooded aspect to the land.

The old harbour is only about 3,000 feet long and 1,000 broad and covers about seventy acres.¹ The depth varies to-day from eighteen to twenty-four feet, but was ample for the early traders. The great asset of Marseilles is the almost tideless sea and the deep water near the coast. These facts have made it possible to construct a number of deep-water basins along the shore of the Rade de Marseilles in the shelter of a mole which has been built along the edge of a submarine platform. The map on the scale of 1/500000 shows the great mole following roughly the thirty-foot line. Outside this there is a sudden drop to a hundred feet. The newest basins have a depth alongside the moles of over forty feet at low water. A series of inner moles continues to the bay of Estaque, at which point the limestone uplands reach the coast. Here the Marseilles railways have to tunnel. One branch, by dint of difficult engineering work, following the coast and the other cutting through the upland in a long tunnel. The new Rove canal leaves the harbour of l'Estaque and traverses by tunnel the same upland a mile or two to the west of the railway. This tunnel is over four miles long, seventy-two feet wide, and can carry 1,000-ton barges. It is carried through the site of the Etang de Bolmon, which is partly filled up, into the Etang de Berre. This great sheet of water covers more than 3,700 acres. Through it runs a depression twenty-five feet below mean tide level, which makes it possible for shipping to avoid the crossing of the gulf of Fos, which is sometimes very rough when the *mistral* is blowing. The southern shores of this great lagoon have been provided with wharves and railway sidings and will form an extension of the port of Marseilles. Entrance to the lagoon is also possible from the gulf of Fos via the Etang

¹ Murray's Guide, 1875.

de Caronte, which traverses the hills separating the Etang de Berre from the Mediterranean. The Etang de Caronte is a drowned valley whose floor has been covered with great depths of silt. The silt has been excavated to form a channel for shipping. Martigues is the railway terminus of this Bosphorus on the inner side, and Port de Bouc is the little port at the sea entrance. This will be the main transit port into the interior if the Rhône canal comes into being. The Corniche railway from Marseilles crosses the channel and passes through Port de Bouc, to connect with the Arles-Rhône valley railway farther north. At this point also the Arles canal reaches the sea. It is, however, not capable of taking Rhône *chaland*s. The merchants of Marseilles envisage a time when a ship canal shall connect Marseilles, via the Etang de Berre and a Rhône lateral canal, with Lyons; but, on account of the immense cost of such a scheme, it is probable that much water will flow under the bridge of Arles before it is realized.

Marseilles is a port which differs from the other great ports of Europe in that it is not primarily international in its function except as a passenger port. It has developed a rôle for itself as the collecting and distributing centre for the French North African colonies and for the French possessions in the Far East. It has established its own lines for trade in the Mediterranean and for traffic with the Orient. It was before the War, and still is, an important port of call, as many as sixty-six lines of shipping utilizing the port. It is a bunkering station of great importance for Mediterranean traffic, standing at an important junction of railroad and sea routes. Before the Great War it used to import about 2,000,000 tons of British coal per annum. It is a great passenger port, for it enables travellers to avoid the prolonged journey through the Bay of Biscay and round the coast of the Iberian peninsula, and has many passenger lines in the Mediterranean. Its imports¹ consist mainly of raw products from the Far East and from Africa for the hinterland of the Rhône valley. Among these oil-seeds take an important position. Silk in every stage of its utilization is imported for the sericulture and silk industry of the immediate hinterland. Cereals, sugar, hides, and tallow are imported for distribution and to feed the local industries of flour-milling, sugar-refining, leather industries, and soap and candle manufactures. Dried fruits and nuts come from Italy, Spain, and Yugoslavia; wine, olive oil, leather goods and alfalfa from North Africa; tea, coffee, and spices from the Far East; dye-woods for the textile industry and timber, especially wood for barrels, from the United States of America.

¹ See Appendix I.

Export tonnage is less than import, for the products of the Rhône basin, both manufactured and agricultural, are valuable relatively to bulk or are perishable and require rapid transport and therefore are carried, where possible, by rail. Exports are largely of manufactured goods—textiles, machinery, etc., for the African possessions, flour and oleaginous products.

The industries of Marseilles are grouped round the old harbour and along the coast. They are already being established on the shores of the Etang de Berre, in the neighbourhood of Estaque and of Port de Bouc. Before the War they consumed over half a million tons of coal per annum. Coal from the Alès field in the Gard department is used, and lignite, which is mined in the basin of the Arc and upper Huveaune.¹ Chemical works,² based on local supplies of salt, phosphates from North Africa, and sulphur from Sicily and North America, are important, including the production of soda in connexion with the soap-manufacturing industries. There are large quarries in the neighbourhood of Marseilles for limestone and large lime and cement works. Most industries are based on local raw material or on material imported by sea. For example, imported tallow and oil-seeds, local oil and scent from the department of Var feeds the soap, candle, and margarine factories. Sugar refining is based on the import of sugar from the French colonies. The import of hides from Argentina and from India is related to the Marseilles tanning industry. Cork factories utilize the cork from the Maures and Esterel. But Marseilles, unlike Danzig and Hamburg, has no free port in which manufacture for re-export and the processes, associated with an entrepôt port, of sorting, grading, and repacking can be carried on. As a result of this, and also of the somewhat difficult communications, Marseilles has not developed pre-eminently as the centre of an industrial area.

In actual tonnage Marseilles has been equalled and even surpassed by Rouen. It must be remembered, however, that Rouen is a specialized port, and that the great bulk of its traffic consists of imported coal, whereas Marseilles deals with a very great variety of imports and exports, many of which have high value in proportion to weight and bulk.

Marseilles is a port of many nationalities. Twenty per cent of the population of the canton of Marseilles are foreigners, chiefly Italians.³

East of Marseilles the coast sweeps round in a broad curve

¹ The Fuveau lignite basin is the most important. The output was worked up to 1,000,000 tons during the war of 1914-18. In 1936 production was 631,200 tons: two-thirds of the total for France.

² The French production of superphosphates in 1936 was 118,000 metric tons—fifth in the world.

³ *Recensement de la Population, 1936.*

towards the gulf of Genoa. It presents, however, by no means an unbroken line. The alternation of limestone ridge and plateau with alluvial floored vales and depressions continues. Three great masses of wooded upland shut off the interior from the coast and force the lines of communication into restricted channels. The first of these lies behind Toulon, and is but a more compact version of the ridge and vale system which lies to the north of Marseilles. The vegetation which covers the slopes is of the *maquis* or *garrigue* type. The enclosed depressions, where irrigation has been carried out, are cultivated wherever the jutting masses of rock, which are nowhere far from the surface, do not make cultivation impossible. In traversing these depressions one of the things that strikes the traveller most is the hard struggle that the agriculturist has with the rock and the drought. Scarcely anywhere can one see a large patch of cultivation. The patient peasant of the Midi has often to be content with a pocket of soil here and there, and he certainly makes the most of it. The coastline here is typical of much of the Mediterranean coast, both in form and vegetation. Jutting headlands correspond to the remnants of eroded, fractured, and submerged mountain chains. Extensive gulfs, *calanques*, such as the Rade de Toulon, represent the drowning of a clay-floored depression. Railways and roads follow the valley-ways and tunnel through or zigzag over the uplands. The edges of the promontories drop by steep cliffs directly into deep water of 150 feet and more, as, for example, to the south of Marseilles and in the peninsula of Cape Sicié. The population is sparse in this district and would be more so but for the development of the cultivation of *primeurs*, for the uplands can be utilized only for sheep-rearing.

The naval port and arsenal of *Toulon* lies on the southern slope of a steep limestone ridge which overlooks a great triple harbour formed by the submergence of an east to west vale. It is protected to the south by rocky promontories, which carry fortresses. The commercial port does a small trade in coal, wine, and timber. Bauxite is exported. La Seyne on the Petite Rade facing Toulon has great ship-building yards. There is a large Italian population here, as at Marseilles.

THE MAURES AND ESTEREL. East of Toulon lie the great masses of the Maures and Esterel composed of archæan and primary rocks. They are a remnant of a continental mass which occupied at one time the area of the Tyrrhenian Sea. The coastal islands of Hyères and the large islands of Sardinia and Corsica are also remnants of this land which formed part of the Hercynian mountain system. With the appearance of the hard and

impermeable rocks of the Maures the character of the whole country changes. Instead of dry valleys we find, at all events in the rainy season, streaming waters flowing in deep trenches like those of the Central Massif. Steep hill-slopes, instead of carrying *garrigue*, are covered with bracken and stunted *maquis*, but the valley-slopes are clothed with a dense cover of Spanish chestnut. The effect of the large amount of surface water and the more rapid run-off that result from the impermeable subsoil is a tendency to a building up and simplification of the shoreline. Silting up of the coast between projecting islands and promontories is going on here as it is along the Aegean. The Rade d'Hyères has been formed by the building up of sand-spits, which have linked the rocky island of Giens with the mainland. Hyères is now two and a half miles from the sea.

The inhabitants of the Maures and Esterel dwell in scattered hamlets and villages away from the main lines of communication. Only one reasonably good road traverses the upland. The cork oak is cultivated in the interior, and the golden yellow of the stripped boles is a striking feature of the forested hills. It takes from eight to ten years after the first bark has been stripped off for the cork to form. Cuers is an outlet for the export of corks made in the villages. The chestnut is an important article of diet. There is a certain amount of sheep- and cattle-rearing in the highlands. There is no good coast road here, but a light railway joins St. Tropez with Hyères and Toulon, passing along or near the coast. The main road avoids the coast altogether, for where the rugged rocks descend into deep water it is much indented, and reminds one rather forcibly of the south coast of Brittany, at least as far as land forms are concerned. There are a number of small fishing-ports where tunny fishing is important.

Between the ancient Massifs of the Maures and the uplands of sedimentary rocks to the north runs a broad depression (a Permian geosynclinal). It passes in a north-eastward direction from the coast at Toulon and meets the coast again at Fréjus. In the neighbourhood of Le Luc it joins another depression, which is drained from the west by the Argens and which then passes north-east round the north of the Esterel. The western extremity of this depression, which is filled with Triassic rocks, communicates over a low divide with the Tertiary basin of Aix-en-Provence, whence routes are possible north-west to Avignon and Arles and south-west to Marseilles. By this series of open basins, which owe their origin to earth movements and subsequent erosion, the main road runs from Aix to Fréjus. It passes behind the Maures to Le Luc, crosses the water-parting into the Brignoles

basin, thence into that of St. Maximin over another low *col* through which the railway tunnels, into the basin of Trets, and then follows the valley of the Arc into the basin of Aix-en-Provence. A steep climb then leads over a series of limestone plateaux to Avignon or Arles. This was the line of the main east to west Roman road from Rome to the Rhône valley. Aix-en-Provence at one end of this corridor was probably the first Roman settlement in Gaul. It was fortified in the time of Augustus. The selection of the site was no doubt due in the first instance to the mineral spring which gave the town its name, but the relatively fertile clay basin, sheltered from the *mistral* by the steep palisade of the Lubéron plateau, probably added to the attraction of the site.

Turves, Brignoles, and Le Luc are in the centre of the bauxite district.¹ The ore (hydroxide of aluminium) occurs in the Lower Cretaceous rocks (Urgonian), and is mined at a number of places in the Argens valley. The magenta red clays of the Argens valley form a sharp contrast to the vivid white and yellowish-grey of the limestone hills to the north and to the dark rocks of the archæan Massif to the south. The department of Var accounts for 84 per cent of the total French bauxite production. The clay is carried by carts to the stations of Brignoles and Le Luc, whence it is railed to the coast for export from St. Raphael, Toulon, and Port de Bouc, and northwards into the Alpine valleys, where the alumina is extracted and aluminium is smelted by electrolysis.² The clay soils of this depression are relatively easily irrigated, and the vale produces, besides olives and vines, early vegetables and fruit and flowers. The cultivation of flowers continues along the terrace gardens of the ' Côte d'Azur '.

Fréjus, north of the mouth of the Argens, was the Roman military port for the Rhône valley, but is now a mile from the shore, which is of the usual sand-spit and lagoon type,³ and has degenerated into a dreary and insignificant little town, shrunken within its walls, and the quays and jetties of the Roman port are buried in the silt. St. Raphael, better situated to the north

Year	French Bauxite		Aluminium production
	Production	Export (in terms of metal)	
1926 . .	531,000 tons	251,000 tons	20,000 tons
1936 . .	550,000 "	19,600 "	27,000 "
1937 . .	580,000 "	25,900 "	35,000 "
1938 . .	580,000 "	95,100 "	45,000 "

Figures supplied by the British Aluminium Company.

¹ See Chap. XIII, p. 447.

² See p. 315.

of the Argens delta, so that it receives none of the silt from the river, has a certain amount of traffic. It exports bauxite, which is railed from Le Luc in the Argens valley and carted to the boats, covering the hedgerows and buildings with red dust. Paving-stones from the quarries on the coast of the Esterel are also exported from this port. (Bauxite from France is refined at Larne and Burntisland, whence pure alumina goes to the hydro-electric installations of Foyers, Kinlochleven and Lochaber, to be reduced to metallic aluminium.) The town has become an attractive seaside resort, with its rocky coast with pine trees growing down to the water's edge, palm groves, bright gardens, cheerful villas, brilliant skies and sea. It is not, however, sufficiently sheltered from the *mistral* to become a great winter resort. The coasts of the Esterel towards Cannes are much more sheltered. Behind the coast the beautiful Massif of Esterel has been opened up to the tourist. A *corniche* road follows the rugged coast, with its red rocks, numerous deep-watered inlets or *calanques*, jutting promontories, and numerous villas; and a national road takes the inland route, also beautiful, which follows the watershed of the Massif. Beyond this road the Massif stretches inland, in the scarcely known wooded upland of Tanneron, covered with cork oak, holm-oak, and pine, and all the familiar *maquis* plants—myrtles, cistus, etc.

Beyond the Esterel the basin of Grasse continues the intermontane depression. Here again *primeurs* and flowers are cultivated and Grasse is the centre of the perfumery industry which employs the essence of real flowers; violets, roses, orange blossom, jasmine, thyme and lavender, and many other flowers and herbs are cultivated for this purpose.

THE RIVIERA. With Cannes and Antibes we return to the limestone ridge and the broken coastline of the Toulon-Hyères type. Cannes is sheltered from the *mistral* and the rough east wind by the Cap de la Crosette, from the west by the Esterel. The old town lies on a bluff, west of the river and the little harbour. Its three and four-storied, red-roofed houses rise in tiers to the sailors' landmark of the Mont Chevalier with the church of Notre Dame d'Espérance. The new town, with its hotels and *pensions*, covers the site of a reedy delta, around which the original fishing-village stood. Antibes, facing east, was a frontier fortress when Nice belonged to the kingdom of Sardinia. The destruction of its fortifications, now no longer needed, has given it a chance to expand and take advantage of its beautiful position to acquire a share of the prosperity that the tourist has brought to the littoral of Provence and to partake in the cultivation of flowers for export. Cultivation under glass in order to

gain a week or two in the production of *primeurs* both for flowers—roses and carnations—and fruit for the hotels of Cannes, Nice, Monaco, and Menton, and for the cities of the north, is a speciality of Antibes. In the neighbourhood of this town the character of the coast changes. The ranges of the Maritime Alps swing round here at right-angles to the coast and the rivers flow southward in deep, parallel valleys. Between Antibes and Nice the Var finds a narrow exit.

Nice has developed as a great winter resort of 235,498 inhabitants, at the outlet of the river Paillon. Its small harbour lies, as usual, to the east of the river. Like Cannes, the town is sheltered on the north-east, but the mountains rise to 2,000 and 2,500 feet behind Nice, so the shelter from the *mistral* is complete. Citrous fruits are cultivated for commercial purposes here, but exportation is small. Olive oil is the main product of the Nice district and cut flowers are exported in large quantities in the early spring. The opening in 1928 of the new railway line, which crosses the frontier via the Col di Tenda to Cuneo, provides Nice with much-needed communication with the interior and with improved access to Turin and the St. Gotthard route. The new Cuneo railway is a single track which avoids the long route through Savona. Nice is one of the ports for Corsica.

The principality of Monaco includes the centres of Monaco and Monte Carlo. They are pleasure-resorts with advantages typical of this sheltered and accidented coast of the Maritime Alps. Menton has a considerable inland trade in lemons. The citrous fruit industry has been hardly hit by the developments in California and Florida.

The broken nature of the country has made necessary a complicated system of frontier fortification. The deep gulf of Villefranche is a naval station for protection against attack by sea.

CORSICA

The island of Corsica is a miniature Central Massif, surrounded, however, not by depressions in terra firma like the sedimentary basins of the mainland, but by great marine deeps. Its margins therefore are more clearly defined than those of the larger Massif. The ancient rocks of granite and schist that form the upland of Corsica, too, lack that girdle of massive limestones so conspicuous in Central France; nevertheless, if we imagine the sea to rise around the Central Massif to a height of, say, 600 feet above its present level, we should have a great island bearing a striking resemblance to the island of Corsica. Comparing the smaller block with the larger, we find the same dissected plateau of

granites and gneisses, and the same Hercynian trend of the component rocks reflected in the features of relief and drainage in the west and south ; only here the valleys, broadening to the basin of Aquitaine, are represented by the great drowned gulfs of Porto Sagone, Ajaccio, and Valinco. The western exposure has strengthened the erosive powers of the rivers in both lands. The abrupt drop of the eastern edge of the Massif finds a counterpart in the sharp, unbroken descent of the island to the sea or to the thalassic plain. The jutting mass of the Morvan corresponds to the stark promontory that ends in Cap Corse. The depressions of the Loire and Allier basins find, in the series of sedimentary basins that run northwards from Venaco to the coast, if not replicas yet features of the same type. The coal measures which we have noticed on the flanks of the Massif are represented by the anthracite of the Carboniferous basin of the Fango valley in the west. Shall we be accused of pushing the analogy too far if we liken the small karstic plateau of Bastia, wedged between masses of crystalline rock, to the Causse de Rodez ?

Climatically, of course, the contrast between the two areas is great. But this does not apply to the higher regions of Corsica, where cooler conditions and a heavier precipitation have induced a vegetation not very dissimilar from that of the Central Massif. Owing to torrential erosion, and the exposure of peculiarly hard intrusive rocks, of which there is much evidence in the higher part of the island, the ridges of Corsica tend to be sharper and the land forms generally less rounded. There are broad, flat-bottomed valleys in the upper courses of the rivers that drain from the high block of upland in the north-west which culminates in the Mont Cinto, 8,890 feet high, from which the rivers descend in rapids and waterfalls through deep gorges to the main valleys below. Here and there well-formed cirques have been observed.

The climate of the lower lands of Corsica is typical of the Mediterranean peninsulas. The olive is cultivated and also citrous fruits. The cold of winter in the highlands is modified by marine influences, and the contrast between the rainfall of east and west is less marked than on the Italian peninsula, for example. Sardinia and Corsica are windy islands, the prevailing winds coming from the north-west and south-west, especially at the turn of the year. The Sirocco, or south-east wind, is strong and stifling, but of rarer occurrence than the westerly winds.

Vegetation varies chiefly with the elevation. *Garrigue* makes a pretence of clothing the flats with herbage, *maquis* of a very dense type effectively covers the intermediate slopes. The *cistus*, or broom, with its heavy scent, is particularly remarkable

Feet above Sea Level

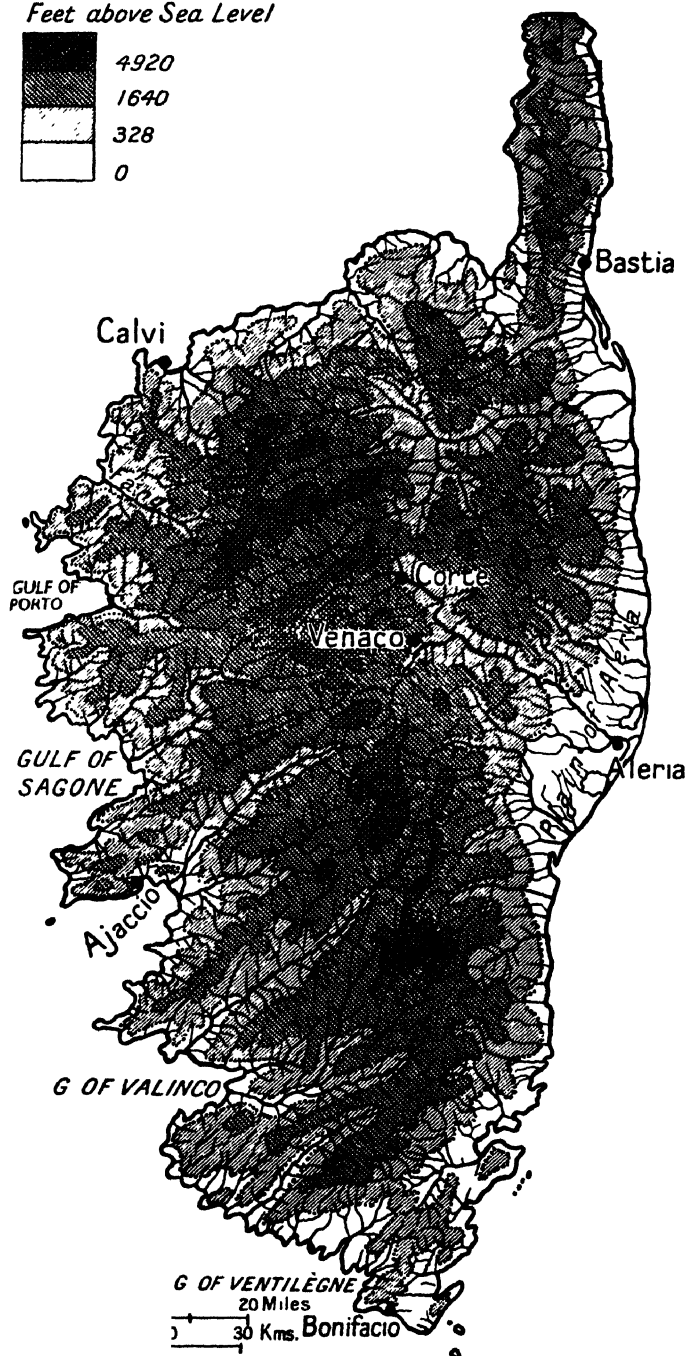
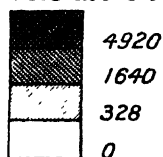


FIG. 58. THE MASSIF OF CORSICA

in this formation. In most of the higher valleys, and particularly in the north-west, the slopes are covered with forest, mainly of fine chestnuts, but with pines and deciduous trees interspersed. The chestnut is the mainstay of the life of the people. It is in the region of the chestnut forest—that is to say, half-way between the coast and the high mountains—that the life of the typical Corsican has developed. There is so little land suitable for cereal cultivation that most of the farming is pastoral. On the other hand, these upland valleys, whence the streams descend by deep and often inaccessible gorges, are so isolated that, until recent years, the scattered groups of inhabitants had to be self-sufficing, and the chestnut has provided, and still to a great extent provides, a staple article of diet. The tree does well up to a height of 3,000 feet on the intermediate slopes between the olive and citrous fruit trees at the base, and the stunted conifers and ash of the heights. The chestnuts are gathered from the ground in autumn, and there is a large surplus for export. In the lower valleys and on the restricted areas of coastal plain, wheat and other cereals are grown.

The plain of Aleria, in the east, with its fertile Tertiary marls, is capable of producing good crops. Unfortunately the lagoon shores are malarial and the population is relatively small and labour scarce. As M. de Martonne has pointed out,¹ Corsica is not, from the point of view of settlement, a maritime region. It is a land of mountaineers forced by geographical conditions and by hostile aggression from the sea into isolated groups among the highlands. The succeeding conquerors of the island needed its shores as a naval base, a *pied à terre*, or a *point de départ* for marauding expeditions. The poverty of the hinterland was no matter. But these coastal settlements never developed into anything permanent or national. Such truly Corsican centres as developed in the island are to be found in the tectonic furrow of the interior, where the erosion of sedimentary rocks, preserved between the archæan masses, has resulted in a series of relatively fertile basins. Venaco, Corte, Omessa, Costifao, Lama, Palasco, Belgodere are all related to this line of depression.

The towns of the coast—Bastia, Calvi, Ajaccio, Bonifacio, Porto Vecchio—are more or less united by a coastal road, but they have had but few relations with the interior. Aleria, on the east coast, on a little hill overlooking marsh and lagoon, was a Roman settlement. Bonifacio, in the south, on a rocky promontory which forms the side of a deep *calanque*, had its origin in a fortress founded by Boniface II of Tuscany, as a

¹ E. de Martonne: *Les grandes Régions de la France — Région Méditerranéenne*, p. 29.

deterrent to invasion, during his struggles with the Saracens who invaded the island at the beginning of the eighth century, and who remained more or less in possession of it for a couple of hundred years. Bonifacio later became a pirate base. Bastia, in the north-east, also on a jutting promontory which commands the coast road and the road across the peninsula to St. Florent, was founded in 1383 by the Genoese to support their control over the island.

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EASTERN FRANCE: LORRAINE AND THE SARRE
COAL-FIELD; ALSACE

ALTHOUGH the hyphenated name 'Alsace-Lorraine' has been, since the Franco-Prussian War, 'familiar in the mouth as household words', it is a term not recognized by the inhabitants of those two lands. Indeed, geographically, Alsace and Lorraine form two very distinct units. True, they developed early under the same cultural influences, and they are united in the advantages and disadvantages of being border provinces of such economic and strategic significance that their inclusion within either France or Germany is inevitably a matter of importance to Europe as a whole, as well as to the countries directly concerned. But the characteristics that distinguish them are so many and so marked that it will be well to describe them as separate geographical units before pointing out those interests which they possess in common.

Whereas Alsace is an integral part of the Black Mountain system of the Rhine, Lorraine belongs largely to the scarp lands of western Europe, and is attached geologically to the Paris Basin. While Alsace is essentially a section of the deep, enclosed plain of the Rhine Rift Valley, shut off by the steep, faulted edge of the Vosges Massif, Lorraine is a high-level land, consisting of upland basin and scarp-edged plateaux. Climatically, the two regions stand in sharp contrast to one another: Lorraine has a bleak winter, and her skies are often overcast; Alsace, on the contrary, has clear, sunny skies and her rainfall is markedly less than that of her neighbour. The stiff, cold soils of the wheat-lands of Lorraine have little in common with the light, rich loess soils of the Alsatian plain. The Vosges upland, though common to both provinces, offers sharp contrasts in settlement and cultivation in its eastern and western slopes as a result of difference of aspect. True, the textile industry is established in the valleys of both flanks of the Vosges; but whereas Alsace is still mainly an agricultural land, and whereas her industries are based largely upon agriculture,¹ Lorraine owes her importance economically, politically, and strategically chiefly to her iron and

¹ Apart from the textile industry of Upper Alsace, sugar-refining, brewing, tanning, boot- and shoe-making, food-preserving, tobacco manufacture are based on local agricultural products.

coal deposits. With minor exceptions the Lorrainers are French speaking, while the Alsatians speak a dialect of German.

Although the Vosges uplands are not so complete a barrier as

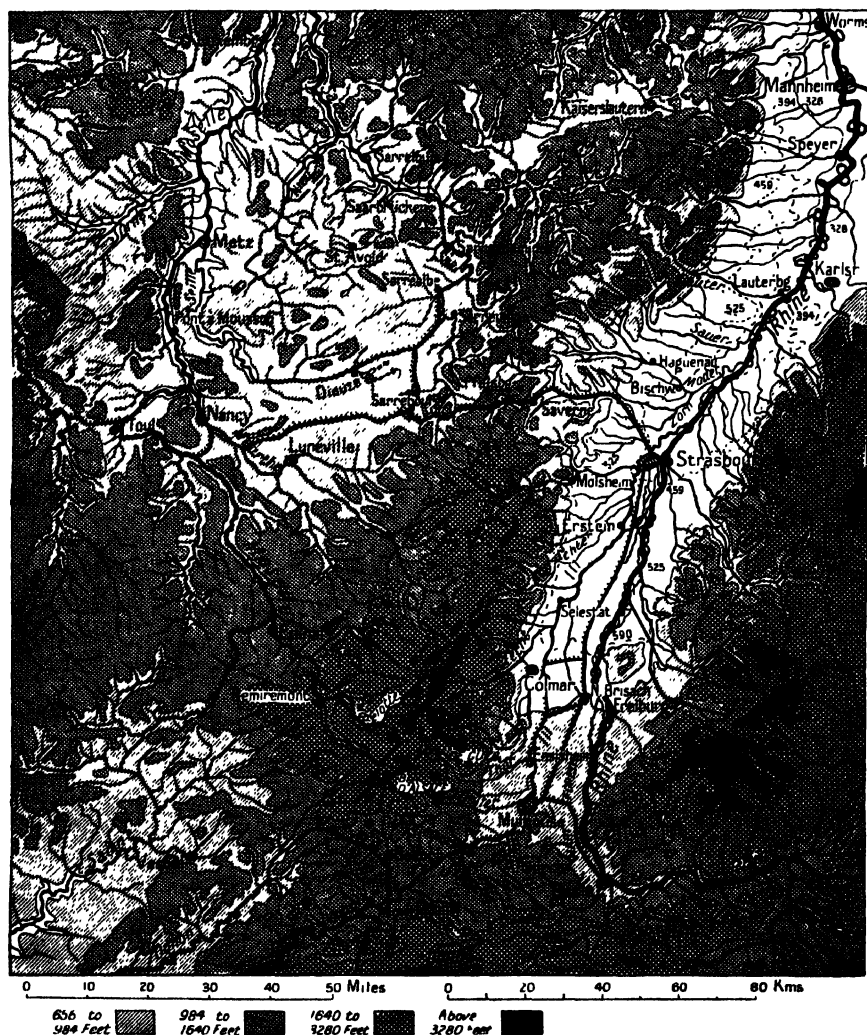


FIG. 59. RELIEF MAP OF ALSACE AND LORRAINE, SHOWING COMMUNICATIONS WITH THE SAÔNE AND UPPER RHINE BASINS

has often been suggested, communication between the two regions is by no means devoid of difficulty ; the Toul Gap and the gaps of the Barrois are easier passages than the Col de Saverne

or the steep-winding route from Pfalsbourg to the Rhine¹ plain. Both countries are parts of passage-ways, but distinct passage-ways, the one from Burgundy to Paris and Flanders, the other the great Rhine corridor.

Having established the individuality of these companion territories, we will consider their claims to be geographical entities, taking first Lorraine, as being the region more closely attached, physically, to France.

PART I

LORRAINE

Lorraine is essentially a transition country, and, as such, its geographical boundaries are not easy to define. It is the transition zone that links the scarp-lands of the Paris basin and the converging drainage of the Seine with the Block Mountain lands and the northward drainage of the Rhine. In Lorraine, the sequence of geological outcrops is continuous with that of the Paris basin, and neither the structure nor the relief makes a satisfactory basis for strict boundaries. It would appear, rather, that the defining feature is a belt of sparse population corresponding to the so-called Corallian uplands.¹ The Meuse, in its deep trench, cutting across the rim of the Corallian plateau, ploughing 'a lonely furrow' due north between the basins of the Seine and Moselle, is as definitely alien to the hydrography of the Paris basin as it is to the basin of the middle Rhine. It is in no sense the central artery of Lorraine; that rôle is too clearly filled by the Moselle. To a certain extent its trenched valley forms an obstacle to communication east and west; and this fact, coupled with the relatively sparse population of its restricted basin, would suggest the divide between the Seine and Meuse basins as the most satisfactory defining line. From another point of view, it must be confessed, there is justification to be found for those geographers who would extend the boundaries of Lorraine westward to include the ridges of the Argonne and the scarped ridge of the Barrois in the Portland limestone, in other words, to make the broad, soggy lowlands of the Champagne *humide* the geographical boundary. Thus it would coincide roughly with the edge of the upland above 600 feet, and would have also the advantage of corresponding with the administrative boundary between the departments of Meuse and Marne. History gives us no clear lead. 'Lorraine, in these earlier centuries, was a debatable land, ill-defined, without unity in itself or permanent attachment to any

¹ See p. 361.

great power.’¹ If we recommend no hard-and-fast line of definition we shall but emphasize the transitional nature of the land. In the south-east the water-parting of the High Vosges forms a satisfactory boundary. North-east the broad belt of forest which clothes the sandstones of the Low Vosges forms a more effectual geographical frontier than the water-parting. The political frontier here is purely arbitrary. To the north a natural frontier is formed by a belt of wooded country which corresponds to the outcrop of sandstone occurring at the base of the Oolite along the southern edge of the Rhine plateau and of the Ardennes. To the south the low water-parting of the Monts Faucilles, between the Meuse and Moselle basin on the one hand and the Saône basin on the other, forms a divide more apparent on the map than on the land itself. Communications are not difficult here, but the arid plateau of Shelly limestone² and the forested sandstones of the westward extensions of the Vosges provide a zone of sparse population.

Lorraine is a region of long, narrow, contrasting strips of land, running north and south; strips of bare or wooded upland alternating with high-level vales and plains of clay. Although it has not the markedly centripetal characteristics of the Central Massif, it was, until the development of its mineral resources, almost completely lacking in geographical features tending to concentration, and even to-day has no one great focal point. The north and south trend of its main features of relief is reflected in the course of its rivers. Only the Moselle, drawing its powerful tributaries from the Vosges across the plain, links, in some sort, the parallel zones together, and may with justice be looked upon as the main artery of the country. The north and south strips fall into three major groups: the Vosges, the plateau basin of the clays known as ‘La Plaine’, and the limestone ridges separated by narrow clay vales and known as ‘Les Côtes’. What, then, is it that holds Lorraine together as a geographical conception? Two facts mainly—its forest boundary and its relatively high altitude.

Consideration of the simplified geological map³ will help to explain *the relation of structure to relief*. The sequence of rocks in Lorraine from the Permian to the Middle Jurassic is remarkably complete, for Lorraine formed part of an inland sea which stretched far to the east during Triassic times and received the trilogy of deposits—Bunter sands, Shelly limestone (*Muschelkalk*), and Keuper marls—which characterize the period. During the Liassic and Jurassic periods the area was covered by the same

¹ Manual of Alsace-Lorraine—Naval Staff Intelligence Department.

² Fig. 60.

³ Fig. 60.

seas that submerged the region of the Paris basin. During the final stages of the Liassic period, owing to local earth movements, conditions favourable to the deposit of iron occurred, these

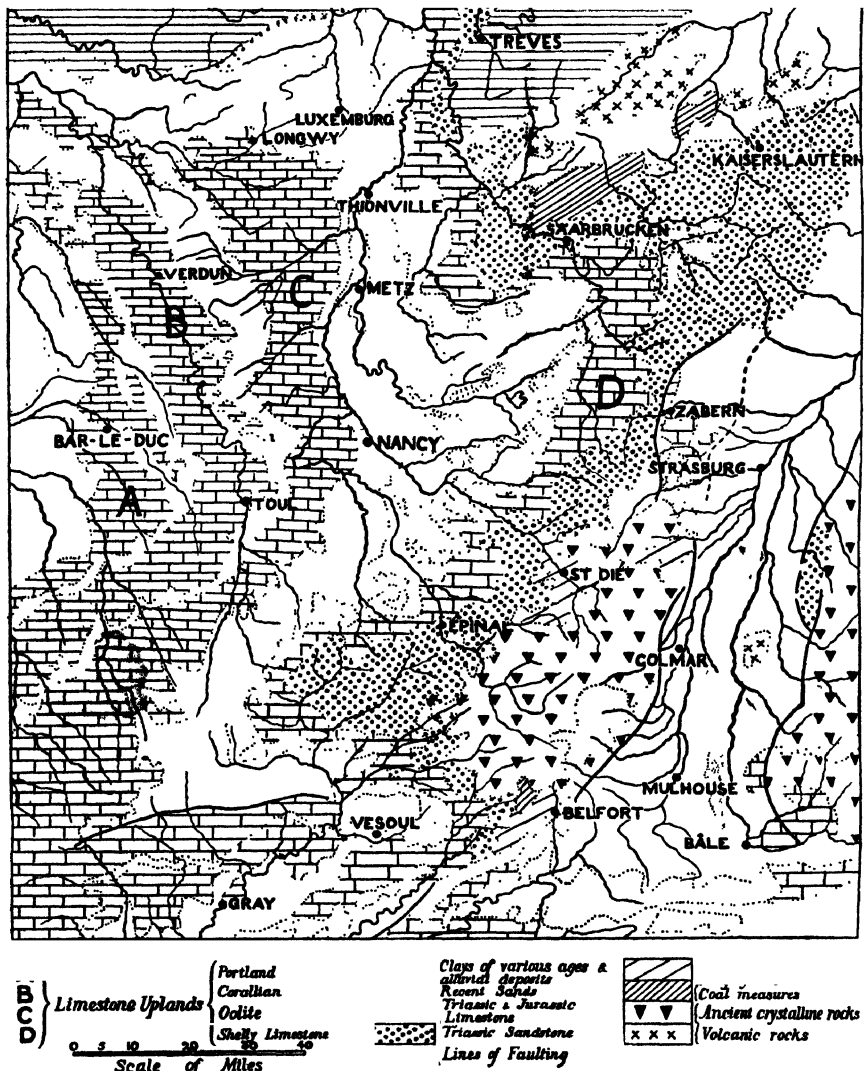


FIG. 60. ALSACE AND LORRAINE. A GENERALIZED GEOLOGICAL MAP

deposits bearing some relation to local depressions. Enormous masses of limestone were deposited in Jurassic times, their deposition being interrupted for relatively short periods by the

laying down of clays. Thus were formed in sequence the Oolitic limestones and clays and Rauracian limestones belonging to the Oxford and Sequanian periods of the Jurassic. These limestones are often spoken of as *Corallian* because of the hard Corallian masses which occur in them and characterize especially the Côtes de Meuse,¹ though the softer Astartian limestones that succeed to them cover a much greater area on the Meuse plateau. After the deposition of the Corallian limestones, shallowing waters brought muddy deposits, now exposed in the zone of the Kimmeridge Clay. The succeeding deposits of Portland limestone which form such an important outcrop on the western boundary of Lorraine did not extend over the whole of the Paris basin. The Vosges-Black Forest Massif had re-emerged at the end of the Middle Jurassic period, and the greater part of Lorraine was attached to it as terra firma during the deposition of the Gault and Greensand in the Paris basin. The foundering of the Rhine Rift Valley began in Lower Tertiary times (Late Eocene), and masses of detritus were washed down into the trough thus formed, which was temporarily occupied by a sea. During the subsequent Alpine upheaval the Rhine trough was deepened and extended; at the same time the Vosges peneplane, with the early Tertiary sediments resting on it, was raised to a great height.² The foundered surface of the Vosges-Black Forest Massif now lies 600 feet below the floor of the Rift valley. Quaternary erosion, during which deep valleys were scored in the Massif, to be widened later by glacial action, removed thousands of feet of Triassic and Jurassic rocks from the summits of the Vosges and deposited the waste on the western slopes of the upland and on the plain of Lorraine. These deposits, largely composed of sands and gravels, have in turn been eroded to form terraces, which are found at elevations of 200 feet above the valley floors. The Rift valley, meantime, was partly filled by great thicknesses of deposits from the Alps. In the plain of Lorraine the effect of erosion was the exposure and wearing down of the clays over ever-widening areas, the development and cutting back of steep escarpments on the outer edge of the limestone outcrops and the trenching of steep-sided valleys in the limestone plateaux. The development of the Seine, Saône, and Rhine tributaries at the expense of those of the Meuse³ resulted from the relatively long highland course of the Meuse compared with those of its competitors. The general trend of the rivers is due to the draining power of a depression on the site of the northern Ardennes, which probably formed and stereotyped the river course before the pull of the Paris basin

¹ There is a striking example of Corallian cliffs at St. Mihiel.

² cf. the raising of the Central Massif with the Causses.

³ p. 333.

became active. The Rift valley probably drained both to the Mediterranean, via the Doubs, and to the North Sea, with a divide near the Kaiserstuhl. The deepening of the depression to the north gave the Rhine power to capture the southern drainage. We see, then, that the relief and drainage of the land to-day is closely related to the geological structure of the region.

THE VOSGES. The Vosges rise steeply from the fractured edge of the Rhine Rift depression and from that of the Burgundian gate to flat-topped summits, about 3,000 feet above sea-level. On the west also the Massif has suffered fracture, so that it drops by a series of plateaux and terraces to the high plain of Lorraine.

The Vosges Massif is differentiated into the High Vosges and the Low Vosges. The High Vosges lie to the south. They have an average elevation of some 3,000 feet, and bosses of granite rise to over 4,000 feet in the southern end, as in the Bâlon d'Alsace and the Bâlon de Guebwiller, where the crystalline core of the Massif is exposed. The High Vosges stretch from the Belfort or Burgundian gap to the Saverne gap, and send out a broad extension to the south-west, which gradually decreases in height to form a low swell that constitutes, roughly speaking, the southern boundary of Lorraine. The flanks of the High Vosges and the extension just mentioned are covered with Triassic sands of the Bunter series. The Low Vosges lie north of the Saverne gap and stretch as far as the edge of the Rhine Massif. Here the Triassic sands completely cover the crystalline rocks. Although the average elevation is less than in the High Vosges, for their height does not much exceed 1,600 feet, this region has a much lower density of population than that of the higher plateau, except in the part of the Sarre basin where the workable coal measures occur. The Low Vosges have always been a barrier to communications. In the Palatinate, in the neighbourhood of Kaiserslautern, a synclinal depression has preserved a belt of limestone which is exposed in a north-east and south-west band following the Hercynian trend, and is known as the Landstuhler Bruch. This depression, which facilitates communication between Metz and Mainz, is the only natural gap north of that of Saverne. Only the southern portion of this great forested plateau belongs to France, the rest lies within the Bavarian Palatinate and Rhenish Prussia. The two sections of the Vosges are nearly separated by a bay of the Rhine Rift valley, which extends into the plateau to the north of Strasbourg.

In the High Vosges most of the higher land is forested, but above the forest the summits and ridges lie bare of trees and are covered mainly with moor and coarse pasture (*chaumes*), from which granite tors emerge. In some places the ground is covered

with masses of loose rock and stones. Peat bogs (*faignes*) are common, as in the Central Massif, owing to the flatness of the summits.

The absence of forest on the summits is due no doubt in part to exposure, but also to the grazing of sheep and goats from earliest times. To-day the only occupation of the inhabitants of these highlands is pastoral. The lower ridges and the steeper slopes of the numerous valleys are densely wooded with great forests of conifers and, on the Alsatian slopes, with chestnuts. The forests of Lorraine were shockingly mutilated during the Great War, partly by shell-fire and partly by the troops for their own needs. Where the Vosges decrease in height northwards, the crystalline uplands, in which the rivers have carved broad depressions, have been cleared of forest and brought under cultivation. The broad, open basin of St. Dié, however, owes its agricultural development to the preservation, in a depression, of Permian shales and sandstones. The *Triassic sandstones* that cover the flanks of the higher land, over a belt of from five to ten miles in width, are again deeply forested, although at a lower level than the crystalline plateaux, owing to the lack of fertility of the coarse siliceous soil. Thus the lower crystalline zone on the High Vosges stands out as a belt of denser population between two sparsely-inhabited regions of forest and moorland.

It must be noted also that the Triassic sandstone itself varies in nature, the lower strata (*grès bigarré*) being composed of fine sandstone with an admixture of clay, and with occasional bands of marly limestone, and is accordingly less inimical to settlement than the coarse-grained upper Bunter sandstone, or *grès vosgien*, which lies above it and which has been preserved in the lower plateaux, covering the greater part of the lower Vosges.

The *Shelly Limestone*, which overlies the Bunter sands, forms a belt of land, five to twelve miles wide, to the west of the Bunter rocks, contrasting in its relative fertility with the forested sandy belt of that outcrop. Its warm, friable, limy soils support a great variety of crops. On the physical map the zone can be easily recognized throughout its length by the paucity of rivers, in which it contrasts with the clays, and by the absence of forest, in which it contrasts with the more elevated limestone zones. The limestone has weathered into a broken, rolling country, rising gently from 1,150 to 1,300 feet above sea-level at the junction with the Bunter sands. The limestone does not form a definite escarpment as a rule, but there is a notable exception to the west of the Madon, where it overhangs the Forest of Darney for over fifteen miles in a straight line.

THE PLAIN. To the west of the belt of Shelly limestone lies the plain of Lorraine proper, composed of *Keuper and Lias Clays*. Scattered over these clays are patches, sometimes of considerable extent, of alluvial clays or loose, infertile sands. The Keuper marl is a heavy homogeneous clay, very impermeable, very tenaceous, and difficult to work. In the north this zone is drained—in so far as it is drained—by the river Nied. The plain is narrow here between the Rhine Massif and the Côtes de Moselle. The Nied draws its sluggish waters from every point of the compass, and, after an uncertain and meandering course, joins the Sarre a little below Sarrelouis. Farther south, in the upper basins of the Nied and of the Seille, which drains across the plain to the Moselle, in the district known as *Saulnois*, the clay is so impermeable and the surface so ill-drained that a number of lakes have been formed. It is probable that the nature of the soil is not alone responsible for their existence. They may be due in part to depressions formed by solution in underlying salt-beds in the Keuper deposits. Some of them have been artificially enlarged to form fishing-grounds, by damming up their outlets. Seille, Meurthe, and Moselle cross the plain from east to west in its narrowing southern extremity. There is no marked change in relief as we pass from the Keuper marl area to that of the Lias Clay.¹ The plain continues uninterruptedly, but the Lias Clay soils are distinctly less fertile than the soils of the Shelly limestone and Keuper marls. This is reflected in the density of population of the three zones. In spite of the elevation and the relatively bleak climate, the high plain of Lorraine provides good agricultural land. The cold, stiff clays are brought under cultivation with the help of teams of strong horses, for though the holdings are not very large, we do not find here the tiny farms and primitive methods that prevail in the plateaux of archæan rocks. Cereals form the main crop, and supply the flour mills of Nancy, Lunéville and Charmes. Sugar-beet and fodder crops are becoming more usual, and, as elsewhere in France, there is a tendency to increase the area of enclosed grassland. This is marked in Messin (the Metz district), on the Lias Clay soils and in Saulnois on the Keuper marl, where the heavy clays are peculiarly suitable to pasture. This change from cereal to pastoral farming has been accelerated by the loss of man-power during 1914-18 and by the subsequent 'speeding up' in the mining and metallurgical industries of Lorraine, which have made a heavy call on the labour of the agricultural districts, and has been stimulated also by an increasing demand for milk in the industrial districts.

¹ In actual fact the two clay belts are separated by a very narrow outcrop of limestone or sandstone, which only here and there forms a salient feature.

Sheep-rearing is declining also as a result of labour shortage and with the change over to dairy- and meat-farming. The alluvial sands referred to as covering much of the clay on the eastern side of the plain, are of little use for agriculture and are in the main under forest.

LES CÔTES. West of the plain lie the scarped ridges and vales of the region of the Côtes. The Oolitic limestone that forms the Côtes de Moselle overlooks in the south the Lias Clay in a series of steep, broken hill masses, separated from the main outcrop by the valley of the Moselle. Farther north this river follows the scarped edge of the main outcrop with only a few isolated limestone hills representing outliers of the Oolite on its right or eastern bank. The Oolite plateau is very narrow in the south, only five or six miles across, but widens in the north to form the Briey plateau, fifteen to twenty miles wide. The plateau dips gently down towards the west, where the limestone disappears beneath the Oxford Clay in the vale known as the Woëvre. Patches of forest lie upon the Côtes de Moselle, more extensive in the south, where the great forest of La Haye covers the plateau behind Nancy. The plateau lacks water, but a whitish, limy soil makes the cultivation of wheat and oats possible on the less exposed uplands. The Moselle, drawing its powerful tributaries from the Vosges across the plain, has concentrated the life and activities of Lorraine within its valleys and opened a line of intercourse with the outer world. It is the main unifying factor of the country.

Beyond the Moselle plateau the Oxford Clay has been worn into a broad vale between the outcrops of the great Oolite and the Corallian limestones. Where the Oxford Clay dips beneath the latter, the water, putting out from the Corallian escarpment in a line of springs, streams on to the vale and is gathered up and carried eastward, by the Ache, the Rupt de Mad and the Orne, across the Woëvre and clean through the eastward rising plateau of the Moselle. Flowing as they do against the general slope of the land, and against the dip of the strata, these rivers have been forced to trench their valleys deeper and deeper as they flow east, till they traverse the Moselle escarpment in deep gorges to join the main river. In the northern part of the Oolite plateau and Oxford Clay vale the marauding tributaries of the Moselle have not penetrated so far, and the Loison, Othain, and Chiers drain the dip slope to the Meuse. The Woëvre plain forms a strong contrast to the limestone uplands on either side of it. Wet and soggy, owing to the deep, impervious, clay sub-soil, studded with lakes which shine among the patches of woodland on the poorer soils, the Woëvre none the less manages to

produce good crops of cereals wherever cultivation, by dint of assiduous drainage, has been made possible. Generally speaking however, the smallness of the villages—hardly more than hamlets—testifies to the poor return for much labour spent. Here and there, arising abruptly from the marshy plain, stand isolated limestone masses, outliers of the Corallian exposure, steep-sided and waterless, but, to judge from the fact that such hills are the sites of large villages, preferable for habitation, to the marshy plain that they dominate. On one such stands the village of Le Mont Sec, 787 feet above sea-level, eight miles to the east of St. Mihiel.

In the Côtes de Meuse, the long strip of limestone plateau detached from the main mass by the river Meuse is formed of hard Corallian limestone and overlooks the river in a steep escarpment. Deep valleys divide this strip into high, almost detached blocks, difficult to approach, and capped with forest.

The Meuse, which rises in the eastern extremity of the Monts Faucilles, drains the Jurassic rock exposures throughout its passage through Lorraine. Its catchment area in its upper basin is small, for the Marne, draining to the Seine, and the Saône draining to the Rhône, have stolen its head-waters. It traverses the "Corallian" limestone plateau from south to north in a deep and winding valley. The river, meandering somewhat feebly over the flat-bottomed flood-plain some half to three-quarters of a mile wide, appears to be a misfit in the garments of a more robustly developed ancestor. J. Vidal de la Blache has told, in striking passages, the tragedy of the plundered and deserted Meuse.¹ Owing to the low level of the Rhine in the Rift valley, its tributary the Moselle has acquired a steeper gradient than the Meuse, with the result that the Moselle tributaries have cut back, as we have seen, through the Côtes de Moselle, through the Woëvre, and have tapped the Meuse plateau itself. And this is not all, for the Seine, with its shorter course to the sea, has been able to penetrate too, by its numerous tributaries, the Aire, the Ornain and others, into the Meuse plateau. The Aire, before it turns west to the Seine basin, flows parallel to the Meuse for some forty-five miles in the Argonne, where the sandy clays (*gaize*) of the Gault series have been trenched by its parallel streams to form long, narrow ridges and furrows such as we find in the Ash-down forest of the Sussex Weald. The furrows are V-shaped, and their slopes are scored by short streams which enter the main stream almost at right-angles. The sandstone ridges, like the Côtes de Meuse, are forested. From many points of view the upper Aire may be considered as belonging to Lorraine, especially

¹ Capt. J. Vidal de la Blache : *Etude sur la Vallée Lorraine de la Meuse*, 1908.

because of its northward trend and the general elevation of the Argonne. But geologically and in the ultimate trend of its waters it belongs to the Paris basin. Actually the Argonne is a small region apart.¹ As a result of the relatively decreasing power of

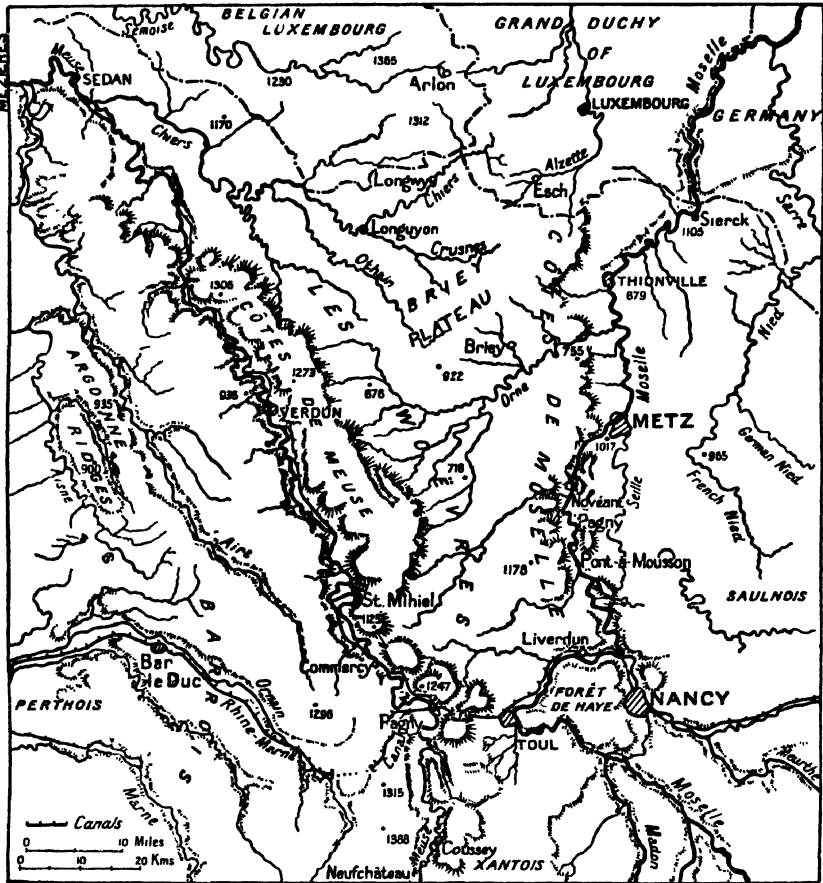


FIG. 61. THE LORRAINE BASINS OF THE MEUSE AND MOSELLE

the Meuse, the valley floor now lies at a much higher level than that of the Moselle.

A consideration in detail of the three major river basins will enable us to develop our study of the region from the economic point of view.

¹ See p. 129.

THE MOSELLE BASIN

THE VOSGES. The high Vosges are penetrated on every side except the south by tributaries of the Rhine. The western, or Lorraine, slopes are drained entirely to its major tributary, the Moselle. This river rises in a number of head-streams in the high moors of the Bâlon d'Alsace and the Bâlon du Cresson. Its upper basin is connected at St. Maurice, by a difficult road which winds from the Col du Bâlon in a steep descent, with Belfort, and, by the Col de Bussang and the Thur valley, with Thann in the Rhine Rift valley. Bussang is a little watering-place at 1,965 feet above sea-level, where the bottling of mineral waters is carried out on a large scale. The Vosges boasts a number of mineral springs in the south-west, related to the lines of faulting. Luxeuil-les-Bains and Plombières have spas. Neither of the *cols* mentioned is crossed by a good road; nevertheless Le Thillot, seven miles downstream from St. Maurice, whence roads diverge towards the *cols* and to Remiremont, Lure, and Gérardmer, was considered during the War to be a strategic point of some importance. Seven miles below St. Maurice-sur-Moselle the Moselotte, the major head-stream, comes in. It rises in the Hohneck, fourteen miles west-south-west of Colmar. This dome of archæan rock, 4,460 feet above sea-level, commands a fine view of the southern Vosges, for it throws the waters off to all points of the compass: the Fecht to Munster and Colmar, the Thur to Mulhouse, the Combe to St. Dié, and the Meurthe and the Moselotte to Remiremont and the Moselle. North of the summit, the Col de la Schlucht carries a main road from Colmar to Remiremont via the glacial lakes of Longuemar and Gérardmer. North and south the ancient *Route des Crêtes* follows the main water-parting for thirty miles or more. The scenery of this part of the Vosges is very beautiful; the vivid magenta red of the Triassic sandstone, the clear streams, the waterfalls and cascades, in contrast to the sombre green of the conifers, forms an attractive setting for the lakes in the valleys. Gérardmer, on the water-parting between the lake of that name and the Vologne, adds to these scenic attractions a thermal station and a large number of hotels, and has a population of about 4,000. The lake drains to the Vologne, whose valley carries the railway to the Moselle and Epinal. From Vagne, the Moselotte flows in a typical wide, flat-bottomed, glaciated valley. Roads, railways, and little towns and villages cling to the valley-sides, avoiding the *thalsohle*, except where a bridge brings them to the valley floor. The upper Moselle valley widens in the same way a mile or two above the confluence with the Moselotte and the town of Remiremont. Here, thanks to a convergence of

valley routes and the railway, and in spite of the elevation of 1,300 feet, is a population of 8,548 with a lace and embroidery industry. On a bluff above the town is a fort supporting Epinal, which lies a dozen miles downstream. Between Remiremont and Epinal the Vologne river comes in on the right. This stream, after leaving Gérardmer and the high plateau, enters at Granges a belt of soft rock, an extension of the St. Dié basin. Here cultivation is general, the forest having well-nigh disappeared, and villages line the valley-slopes. The river meanders in wide-spreading courses, only to narrow again as it crosses the forested crystalline rocks which separate the Permian basin from the Moselle.

Six miles below Remiremont the river Moselle enters the Triassic sandstone zone through a narrow wooded gorge which crosses the forest of Epinal. The strategic value of the fortress of Epinal depended on this forested ridge, trenched by the Moselle gorge, which controlled the roads from Colmar and Mulhouse, by way of Le Thillot. The river passes through Epinal, a mountain torrent still, as the rapids show. The town lies in a cramped position on the valley floor, which here widens somewhat at the entrance of a tributary. It is a route centre of some importance, for the railway from the Burgundian gate passes through it and follows the Moselle down to Nancy, and just below the town is the junction of the line from Dijon. The Canal de l'Est that links the Moselle and Saône navigations across the Monts Faucilles also joins the valley here. *Epinal* is an industrial town. Small, specialized industries, such as glass and paper-making, embroidery and lace-work, date back to very early days, and picture printing is important to-day. Even before the Franco-Prussian War the cotton industry had spread from Alsace into the Lorraine valleys of the Vosges, and after 1872 it was Epinal that organized the industry that migrated from Alsace. The loss of Alsace by France meant a loss of 1,500,000 spindles out of a total for France of 5,300,000, but in twenty years this loss had been made up.¹ The population of Epinal jumped from 8,000 to 28,000 inhabitants in forty years. For thirty miles round Epinal the villages of the valley were engaged in spinning and weaving. The location of the early textile industry was based entirely on water-power, but with the coming of steam-power communications became the deciding factor. The introduction of electric power, which has assumed a certain importance in the Vosges, has retarded the centralization of the industry. In Lorraine, as in other sections of the French textile industry, there is a specialization, if one may so put it, in variety. Thaon specializes in bleaching

¹ R. B. Forrester ; *The French Cotton Industry*, 1921, p. 3.

and dyeing, Epinal in calico printing, St. Dié in coloured goods which imitate woollen and linen fabrics. The industry suffered badly in the War,¹ and, has been embarrassed by the return of Alsace within the French frontier and the competition of the more highly-developed works of Mulhouse and Colmar. The problem of finding markets has proved a serious one. Nevertheless, Epinal, with improved railway communications and rid of the disabilities that attach to a fortress town, will probably recover the population it lost as a result of the War.² There are now about 150 mills employing 50,000 persons.

In the sandstone uplands on either side of the river, cultivated clearings appear here and there in the forest, but the soil is too sandy to be capable of producing good crops, except of fruit. The orchards of this zone, especially the cherry orchards, are famous, as is also the Kirsch manufactured from the fruit.

On emerging from the gorge below Epinal, the Moselle enters the *Plain* and takes on the sedate habit of a mature river. It crosses first the zone of the Shelly limestone, which forms a slight escarpment at the junction with the Triassic sands. Here the fertility of the calcareous soils finds a reflection in the frequency of large, prosperous villages and in the absence of forest. The railway from Dijon follows the limestone outcrop.³ A Roman road from the middle Saône valley can still be traced following the top of the downs from Séveux (Segobodium), north-eastwards in the direction of Saverne, where there were Roman-Gaulish settlements. West of Epinal the belt of Shelly limestone bends southward round the western projecting flanks of the Vosges, forming a distinct sickle-shaped scarp, overlooking the Triassic sands of the forest of Darney, which goes by the name of the Faucilles. From the southern scarped edge the waters drain to the Saône. The dip slope drains by the Madon to the Moselle and by the Vair to the Meuse.

THE MEURTHE. The Meurthe rises on the northern slopes of the Hohnneck, a few miles from Gérardmer, and drops about 2,400 feet in the twelve miles that bring it to St. Léonard, a little below which it enters the basin of St. Dié. Here a tectonic trough, following the south-west and north-east lines of Hercynian folding, has preserved great masses of Permian rocks, of which the most conspicuous is a red sandstone which forms forested ridges, also trending south-west and north-east. These rise to between two and three thousand feet. St. Dié lies at a point

¹ Nine thousand looms and 20,000 spindles were destroyed between 1914 and 1918.

² Population of Epinal in 1911 was 30,000 (*population totale*); in 1936 it was 27,708.

³ See Figs. 59, 60 and 64.

where the Meurthe cuts across these sandstones between two basins worn in soft clays and slates at about 1,600 feet above sea-level. The more south-easterly basin connects with Ste. Marie-aux-Mines by the Col de Ste. Marie and with the Bruche valley by the Col de Saales, to which the road climbs steeply from Provenchères, but from which the gradient down the Bruche valley is easy. The newly opened railway overcomes the steep slope by making a detour of six miles, and by tunnelling. This new link shortens the rail distance from Strasbourg to Epinal by about one-third. The population of the twin basins of St. Dié has greatly increased in the last sixty years, for there was a noteworthy immigration of industry from Alsace after the Treaty of Frankfort (1872). To-day it numbers over 14,400. Textile and machine-making industries occupy the inhabitants of the small towns that succeed one another along the valleys. The old town of St. Dié stands on the slope of a bluff overlooking the Meurthe, while the modern industrial town has developed on the other side of the river along the railway.

On leaving the Permian trough at Etival the Meurthe crosses the Bunter sandstone zone to Baccarat via the gorge of Raon d'Etape and enters the Shelly limestone zone. From Epinal to the Saverne gap the junction of the forest sandstone and the Shelly limestone belt is marked by a succession of towns and large villages, situated generally at the valley exits from the Vosges. The more northerly of these, Cirey, Baccarat, and Rambervillers have important glass-works connected with the Sarre coal-field for power to-day, but originally based on local timber for charcoal fuel and dependent for raw material on the sands of the Bunter rocks. Cirey specializes in plate glass and mirrors, Baccarat in crystal. The extensive forests and the swift Vosges streams have encouraged the sawing and floating of timber, but the ancient hammer forges of the forest have disappeared with the development of the coal-field. Below Charmes the Moselle follows the edge of a narrow outcrop of Rhaetic sandstone, which here forms an escarpment above the Keuper marl. Its flat-bottomed valley is cut deep into the Keuper marl and the slopes rise sharply to over 1,100 feet.

The Moselle and its main tributaries Madon and Meurthe now converge on Nancy in a course that carries them across the rolling country of the Keuper and Lias Clays—the plain of Lorraine—in the district known as *Vermois*. The general level remains between 1,000 and 1,300 feet above sea-level. There is no perceptible change as one passes from the area of the Keuper marls to that of the Lias Clays. The main variety in scenery as in agriculture and vegetation is due to the occurrence of patches

of Quaternary sand, sometimes of considerable extent, which are usually devoted to forest. The forests of Mondon and Parroy, the one between the Meurthe and its tributary the Vesouze and the other between the Vesouze and the Sanon, as also the forest of Vitrimont in the curve of the Meurthe below Lunéville are noteworthy examples. The rivers flow in meandering courses on the clay, in broad marshy valleys. Towards the south they trench through the clays into the Shelly limestone. This gives a certain steepness to the banks and an added fertility to the lower slopes. Small towns of about 1,500 inhabitants lie at intervals of about three miles along the slopes, generally connected by bridge with a settlement on the opposite bank—e.g. Châtel-sur-Moselle with Nomexy, Vinécy with Portieux, Charmes with Le Bout du Pont. Most of these villages have textile factories. The left bank settlements on the Moselle have increased more rapidly than those on the right bank, owing to the advantages provided by the Canal de l'Est and the railway. In the Meurthe the railway and the larger settlements are on the right bank. All these small towns have small industries, chiefly embroidery and spinning mills. Charmes, opposite the forest of that name, is a town of some 3,500 inhabitants. It is the last of the railway towns of this section of the Moselle, for the line leaves the Moselle valley at Vinécy to follow the Oolite escarpment to the Meurthe, twelve miles above Nancy.

Lunéville is the natural centre of the southern part of the plain, which is drained by the Meurthe and its tributaries the Mortagne, Vesouze, and Sanon. It lies actually in the angle formed by the confluence of the Meurthe and Vesouze, but the Sanon and Mortagne join the Meurthe within a few miles of the town. The convergence of routes along the valleys that these rivers have cut through the masses of forested alluvial sands, and especially those coming from the direction of Strasbourg and Sarrebourg, ensured the development of the town. It increased in size after 1870 owing to the establishment there of engineering works by a French firm from Alsace. At the same time straw-hat manufactures were set up as branches of those at Sarreunion in Lorraine-Annexée. In 1875 Lunéville was described as a decayed town of 15,184 inhabitants; by 1889 it had 20,000 inhabitants, while to-day it has a population of 20,673, and in addition to the industries mentioned above makes embroidery and pottery and has developed a large market-garden industry. At St. Nicolas de Port, the Sanon joins the Meurthe, bringing with it the Rhine-Marne canal. In this district are deposits of rock-salt in the Lias Clay. At Varangéville are brine-pits and refineries, as also at Rosières-aux-Salines and at Dombasle, where the great

Solvay works are established, and a dozen other places. Salt is exported by canal to Paris, Rouen, Dunkirk, Lille and Maestricht, and by the Paris-Strasbourg railway.

THE CÔTES DE MOSELLE. The Meurthe and Moselle reach the Oolite escarpment within six miles of one another. The Moselle enters the plateau at St. Vincent, and passes through it to the west. The Meurthe, turning north, follows the escarpment edge for a few miles before it joins the Moselle on its return journey through the plateau. Nancy lies above the Meurthe at the foot and on the slope of the escarpment. Behind the town a section of the plateau, crowned by the great forest of Haye, is almost isolated by the encircling loop of the Moselle. To the north-east of the town lies an outlying limestone rock, so that Nancy lies open to the plain only on the south-east. During the next forty miles of its course the Moselle follows or cuts into the edge of the Oolite plateau of the Côtes de Moselle, known here as the Grand Couronné. Fig. 61 brings out the principal features of this important region.

THE LORRAINE IRON-FIELDS ¹

We will ask the reader to picture a low plateau, averaging about a thousand feet in elevation, stretching for some sixty miles from south to north, having a breadth in the south of only six miles or so, but widening in the north to over twenty-five. This plateau rises gently eastward and terminates in a steep escarpment which overhangs the Moselle valley. The rocks which go to form the plateau belong to the Middle Jurassic series. They consist of alternating layers of limestone and marl which last may be calcareous or arenaceous. The Bathonian or Great Oolite forms the surface of the plateau ; below this comes the Bajocian, at the base of which lie the ferruginous beds called Aalénien and classified by the German geologists as belonging to the lowermost layers of the Middle Jurassic series and regarded by the French as forming the uppermost beds of the Lias.² The iron-ore is exposed in the escarpment on the edges of the outliers and in some of the more deeply incised river valleys. The higher part of the plateau immediately behind the escarpment is heavily wooded ; the lower part, especially towards the north-east, forms agricultural land.

Between Nancy and Metz the Moselle continues its course northward along the eastern rim of the plateau in a broad, flat valley about a mile wide which is shut in on the west by the continuous wall of the Côtes and less continuously on the east by

¹ For a general account of the iron industry of Lorraine, see pp. 440-4.

² M. Gignoux : *Géologie Stratégique*, p. 268.

outlying masses of limestone such as the Bois de Faulx. The Rupt de Mad and the river Orne, with their tributaries, take their rise in the Côtes de Meuse to the west and cut right across the Oolite plateau to the Moselle. The northern edge of the Briey plateau is drained by the Chiers and its tributaries Othain and Crusnes, and by the Alzette. The former flows through Longwy to join the Meuse near Sedan, and the latter flows northward via Luxembourg into the Rhine plateau to join the Sauer.

The iron-ore of Lorraine, then, underlies the Oolitic limestone of the Côtes de Moselle and of the Briey plateau in the Aalénien beds. The characteristic features of the predominating type of the Lorraine Minette ores are, first, the oolitic grains in which the ore occurs, sometimes large enough to be visible to the naked eye; second, the limy matrix which binds these particles; and, third, the presence of phosphorus in sufficiently large quantities to make the utilization of the Gilchrist-Thomas process in smelting as a rule necessary. The following beds are recognized and have received names according to colour.¹ Some are more generally distributed than others. Starting from the top, we find:

- | | |
|---|---|
| 1. <i>Red, Sandy Ore</i>
(40 per cent Fe) | This widely distributed but gravelly and friable ore is used mainly locally to mix with other ores. |
| 2. <i>Red Calcareous Ore</i>
(40 per cent Fe) | This is good Minette ore, but is to a large extent worked out. It is mined on the northern edge of the Briey plateau. |
| 3. <i>Yellow Calcareous</i>
(38 per cent Fe) | This is found between the valleys of the Algeringen and Orne. |
| 4. <i>Grey Calcareous</i>
(31 per cent Fe) | More widely distributed, in thicker bands, more extensively worked, and more generally important economically than any of the other beds. It is worked in all three basins, and the beds vary in thickness from six to twenty feet. |
| 5. <i>Brown</i> }
6. <i>Black</i> }
7. <i>Green</i> } | These beds are gravelly and very little worked. |

The ores, as the above table shows, are not rich in iron content, which varies from about 24 per cent to 42 per cent. On the other hand, there are a number of compensating factors which render

¹ P. Nicou : *Iron Ore Resources of the World*.

the ore profitable to work. In the first place, the dip of the ore-bearing strata is very gentle—only about two to three degrees—and there has been very little folding since the deposition of the Liassic beds. There are, it is true, a large number of faults, following roughly the Hercynian trend, but the displacement is slight, and there are large areas where the ores lie undisturbed so that, on the whole, mining is easy and cheap. Then most of the ores mined have a calcareous matrix, so that they are self-fluxing. They are porous, and therefore readily reduced and require a relatively small amount of fuel for smelting.

The ore-field is divided by faults into separate basins,¹ the most southerly being that of Nancy. This basin was the first to be exploited. It is much smaller and less productive than the others, and differs from them in that the ores are generally siliceous and the iron content is lower—only about 33 per cent. The mines are all worked from adits driven into the edge of the plateau. The reserve is calculated at 200 million tons. A sterile area isolates this basin from the main iron-field to the north. The Briey basin, lying beneath the plateau of that name, is subdivided by faults into three: those of the Orne valley, of Tucquegnieux, and of Landres. This basin is worked by shafts to depths of 300 feet. The ores are mainly calcareous. The Orne valley basin is the most important. The iron content of the ore in the Briey plateau varies from 36 per cent to 42 per cent, and the reserve is estimated to be 2,000 million tons. Owing to the nearness of the ores to the surface, the Lower Orne basin, below Jœuf in *Lorraine désannexée*, is worked by gallery mines, adits from the steep valley-sides being driven into the plateau.

The Longwy basin lies along the northern edge of the Briey plateau on both sides of the Franco-Belgian-Luxembourg frontier. Here the ore is highly siliceous. The mines are all gallery mines or open quarries, for the ore is exposed in the valleys and escarpments, but in the basin of La Crusnes, which lies in the interior of the plateau in the north-west, the grey band is worked by deep mines 350 to 500 feet deep.

The Metz-Thionville basin includes those fields lying in *Lorraine désannexée*. The Fentsch or Hayange basin and the Thionville basin both lie in the department of Moselle. These again, being just behind the escarpment, are worked from galleries. The ore here is mainly calcareous. Within the plateau to the north-east, lies the basin of Aumetz, worked by deep mines like the basin of Landres and Tucquegnieux. In the Thionville basin long galleries are driven into the Moselle escarpment from the neighbourhood of the town of Thionville, and 70

¹ See Fig. 63.

per cent of the mining is by adits into the hillsides. The mines of the north-east corner of the plateau are mainly in Luxembourg, but there are half a dozen gallery mines in the department of Moselle south of Dudelange and a couple of deep mines at Ottange.

For the geographer the most convenient way to consider these mines is in relation to the river valleys, for it is here that the entrance to the mine is usually made on account of facilities of transport, and it is in the valleys, also, that the iron and steel-works are situated, on account of ease of transport and water-supply. It must not be forgotten, however, that in a number of instances the ore is transported for long distances either underground or by aerial or other railways to the smelting works that consume it. Galleries, three or four miles long, pass under the plateau between the Orne and Fentsch valleys.

THE NANCY IRON-FIELD. In the neighbourhood of Nancy the iron is mined in the edges of the plateau that overhang the valley of the Moselle itself, beneath the Forêt de la Haye and the Bois de Faulx. The St. Vincent, Maxéville and Sexey-aux-Forges districts have the largest output in this basin. The last-named place is a reminder of the early period of iron-getting in Lorraine when rich but scattered ores of Tertiary deposits were utilized, and when smelting was carried on by means of charcoal from the upland forests and the forges were worked by hammers driven by the streams. In the Nancy basin gallery mining means that the working is relatively cheap, but, on the other hand, the ore is siliceous, so that calcareous ore has to be brought from the north to mix with it, or lime has to be added; moreover, the coal or coke has a long way to come.

Steel works are situated on the Epinal and Sarrebourg railways and for six miles to the north of Nancy along the Meurthe and Moselle. Thus they all have the advantage of both rail and water transport, for the Meurthe and Moselle are both canalized here, and the Rhine-Marne canal, after serving the salt basin of the Sanon valley, follows the Moselle round the northern edge of the forest of Haye, serving the Maxéville, Champigneulle, Pompey, and Liverdun districts. Two-thirds of the ore exported from the Nancy basin goes by water, mainly to the Sarre.¹ The Nancy metallurgical industry is characterized by the fact that it manufactures mainly finished articles. The reason is partly geographical and to be found in the high freight costs entailed in transporting ores and pig-iron to the Sarre, Ruhr, and northern coal-fields.

The most important metallurgical centre in the Nancy basin is Neuves Maisons on the Moselle, near Pont St. Vincent, where

¹ See p. 488.

the valley widens at the confluence of the Madon. It is the most completely equipped of the iron and steel centres, for it has its own iron-mines, both local and in the Briey plateau, blast-furnaces and coking-ovens. It has a busy port on the Canal de l'Est, by which it receives coal from Strasbourg (Rhine-Marne canal) and sends iron and steel to Strasbourg, Roanne, Lyons, etc., and exports also gas coke and sand to neighbouring glass-works.

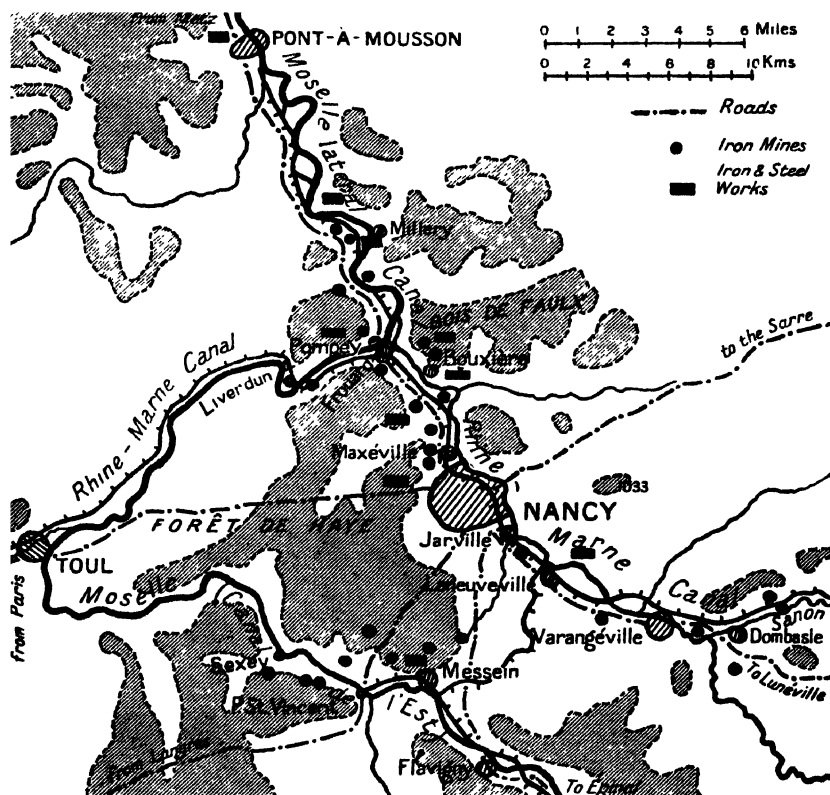


FIG. 62. THE NANCY IRON-MINING AND METALLURGICAL REGION. SHADED AREAS SHOW LAND OVER 1,000 FEET ABOVE SEA-LEVEL.

Fig. 62 shows the disposition of factories along the Moselle and lower Meurthe valleys to the north and south of Nancy and their relation to the iron-mines, which are linked by light railways to the main Paris-Strasbourg line.

Nancy. The modern development of Nancy itself has been due chiefly to the railway, although, with Maxéville, it is a canal port of some importance and exports by water such heavy

goods as iron-ore to the Sarre, pig-iron to the upper Marne, salt, soda, limestone, cement, timber, and building stone, and receives coal from Maestricht, Liège, and Strasbourg. The town has remained detached to a large extent from the extractive and manufacturing industries which flourish in its immediate neighbourhood,¹ and which are themselves a detached portion of the iron-field industrial area. It developed its own industries of textile manufacture, glass-making, barrel-making and hat-making (straw from local material, manilla, and panama). The cotton and embroidery industries received a sharp impetus by the migrations from Alsace after 1872, as did also the hat and barrel industries. The latter requires special skill and exacted the practised methods of the Alsatian workers. The making of modern furniture is an industry in which Nancy has specialized, and there are tanning, leather and boot and shoe industries. Tanning bark from the neighbouring forests gave rise to many small tanning industries, which now have disappeared, leaving the field to big works in the larger towns. The population, which in 1870 was about 53,000, rose to 80,000 in ten years. The glass industries are based on local sands and traditional skill in printing and engraving. A modern development, which is interesting in view of the primary nature of the Lorraine iron and steel industry as a whole, is the manufacture of electrical apparatus and the growth of a light engineering industry. The function of Nancy as a strong point on the line from the Rhine to Paris is no longer as important as it was when the frontier lay in the Vosges, and the population of the town has diminished. In 1911 it had reached 119,800; by 1926 it had been reduced to 108,400.² It is to be expected that its commanding position as a route centre will continue to be of advantage to it in its industrial and commercial development.

THE TOUL GAP. The Moselle, as we have shown, crosses the Oolitic outcrop to the south of Nancy and makes as though to join the Meuse, entering the Oxford Clay vale at Toul. This belt of clay is narrow—not more than three or four miles wide. On entering it the river turns north and then east, abandoning its former westward valley, which is now drained by an obsequent stream. The fortress of Toul stands in the angle formed by the junction of this stream with the Moselle. The Rhine-Marne canal runs along the north side of the fortress. Outlying blocks of Corallian limestone, occupied by the forts of Ecrouves and St. Michel protect the town on the north. More fortresses occupy the edge of the Corallian escarpment to the west, and the

¹ Maxéville, which has small smelting-works, is, however, almost a suburb of Nancy.

² By 1936 it had risen again to 112,366.

whole steep-sided Moselle valley leading through the plateau bristles with fortifications. The main line from Strasbourg to Paris follows the Moselle across the plateau, the high road takes a shorter cut across the plateau through the Forêt de Haye; the Rhine-Marne canal utilizes the passage cut by the river in its return journey. To the north of Nancy the Moselle resumes its course northwards through the eastern rim of the Oolitic limestone plateau, flanked on its right bank by the outlying masses of limestone. Apart from the Rupt de Mad it receives no further tributary of importance till it reaches Metz, where the Seille joins it, bringing the water collected in the Lias plains of Saulnois and Messin.

The Nancy iron-basin extends for half a dozen miles north of that town to Pompey, and the metallurgical industries continue to *Pont-à-Mousson*. The output of ore here is small, but Pont-à-Mousson is a very important centre. Like the other concerns of the Nancy area, it deals in finished articles and specializes in iron pipes, which it exports to all parts of the world. It has considerably increased its output since the War. The coal comes from locally owned mines in the Campine, Aachen (Aix-la-Chapelle), and Sarre coal basins. Coking is carried on locally, and the ore comes from locally owned mines in the Briey field. The metallurgical undertakings here are as important as any in France.¹

North of Pont-à-Mousson the Moselle winds peacefully through purely rural country, still following the escarpment of the Oolite plateau. This non-industrial stretch corresponds to a barren section in the ferruginous deposits. At Pagny-sur-Moselle the river crosses the line of the former Franco-German frontier. Novéant, in Lorraine *désannexée*, is a rail-canal coal dépôt and sends pig-iron to Paris and Rouen and exports sand and gravel. Here the mining begins again, and at Ars-sur-Moselle the metallurgical industries reappear. Between Novéant and Ars the Moselle valley narrows suddenly, facilitating bridging, and at Ars we find an isolated group of iron-works. The Roman aqueduct that supplied Metz took advantage of the narrowing of the valley to cross the river here, and its ruins may still be seen. Below Ars the valley broadens again to form a flat, marshy plain traversed by the river and lateral canal.

METZ. Metz lies in the angle formed by the junction of the Seille and Moselle. Sheltered from the west winds by the Oolite escarpment, the plain of Metz enjoys a sunnier climate and a winter less bleak than do the towns of the open plains. The limestone slopes are covered with vines, whose annual output,

¹ Axel Sömme: *La Lorraine métallurgique*, p. 88.

however, varies greatly, both in quality and quantity, owing to variable climatic conditions. The position of the town of Metz below the edge of the plateau, embraced by the converging watercourses, resembles that of Toul; but the hills do not overhang the town so closely and the alluvial plain is much wider. The fortress, like that of Toul, was a Gaulish stronghold. It became a Roman station (*Divadorum*), on the road from Frankfurt and the Rhine, via the Kaiserslautern Gap. It has maintained its importance first as a free Imperial city, then as the seat of a prince bishop, later as the great frontier fortress of France, or of Germany, as fortunes changed. Under the German occupation the old town walls and the canal were turned into avenues. Vauban's strong fortifications were partly demolished and replaced by a double ring of forts on the escarpments commanding the town. Metz, thus strengthened, proved a formidable barrier in the Great War. The French were heavily defeated south of Metz in the battle of Sarrebourg in August 1914, and the fortress held up the advance of the Allies after the American success at St. Mihiel. The town has been opened to include the suburbs that were developing without the walls north and south along the flood-plain, and the railway now passes through it. The growth of the suburbs was necessitated under the German régime by the influx of Italian navvies to work in the developing mine-fields and to carry on the extensive works of fortification. To-day, with the diminution of the garrison,¹ Metz is likely to develop industrially. Its chief industry, that of fruit and vegetable growing and preserving, has had a steady development. The preserving of meat has been added, and Metz table delicacies have a world-wide renown. The warm, limy soils of the Côtes have encouraged the cultivation of the famous Mirabelle plums, which form an important article of export. The industry of wine-making is another gift of the sunny Côtes, while the rich, calcareous alluvium in the protected flood-plain has been utilized north and south of the town for the intensive cultivation of strawberries, peas, and asparagus. The two last form important items in the packing industry. Raw materials, such as mushrooms from Paris and truffles from Provence and Aquitaine, are imported for the industry.

THE METZ-THIONVILLE IRON-BASIN. The iron-field boundary coincides with the pre-War frontier from the neighbourhood of Novéant as far as the Metz-Verdun railway; but, with the exception of Ars-sur-Moselle, there is no development of the fields south of that line.

¹ The Germans had, according to Dumazet, 25,000 men in barracks in Metz and in the suburbs

It is not until we have passed the north and north-west fortifications, which stretch in a radius of five miles from Metz that we reach the industrial region of the Metz-Thionville basin.



FIG. 63. THE METZ-THIONVILLE, BRIEY AND LONGWY IRON-MINING AND METALLURGICAL AREAS

The first indications of the 'Black Country' are the blast-furnaces of Maizières-sur-Moselle, six miles north of Metz.

In the Briey plateau, drained by the rivers Orne and Fentsch,

the Oolitic outcrop widens till in the latitude of Thionville it attains a breadth of twenty miles. In the south the Orne, drawing plentiful waters from the Woëvre, has pushed back its tributaries into the west centre of the plateau. The rivers Othain and Crusnes, draining north-westward to the Chiers, have done likewise. In these head-water valleys and dry tributary valleys, mines have been sunk to tap the ore strata which dip towards the west. In the department of Meurthe and Moselle eight deep mines have been sunk between Jœuf and Ste. Marie-aux-Chênes, near Briey in the basin of the Orne. In the lower Orne basin, where the streams trench deep into the plateau as they near the Moselle, and where, owing to the dip of the strata, the ore is nearer to the surface, gallery mines occur. The Moyeuvre-Rombas concessions, a mile or two below Jœuf in Lorraine *désannexée*, include some eight mines worked on the gallery system. The Maizières blast-furnaces are fed with ore from the Ste. Marie-aux-Chênes group, by an electric railway. Hagondange, on the Moselle, taps the same district by an aerial railway.

The former frontier between France and *Lorraine annexée*, which left the Moselle at Novéant, followed the divide in the plateau between the Orne and Moselle, and then, passing south of Jœuf, crossed the Orne between Jœuf and Moyeuvre, so that the deep mines belonged to France and the gallery mines to Germany.¹ The ores of this section of the field are entirely calcareous, and therefore self-fluxing. Briey, which has given its name to the iron-field, has only 2,500 inhabitants, for the concession in that district is not yet exploited. The town lies on the Woigot, a small left-bank tributary of the Orne. Among the head-waters of the Woigot and those of the Othain and Crusnes, on the other side of the main water-parting of the Briey plateau, there are a number of concessions between the villages of Dommarmy and Trieux. Here, in the heart of the plateau, the mines are deep because the valleys are not deeply trenched and the strata are dipping towards the west.² This is an area of relatively recent mining development. There are no iron and steel works here, partly owing to the difficulties of water-supply. Fig. 63 shows the situation of these deep plateau mines, the small agricultural villages, and the large miners *corons* with rectilinear block of dwellings, each to accommodate two to four families. There is little that is rural about these annexes, unless it be the ubiquitous pigs and fowls of the miners.

¹ Fig. 63.

² In 1937 the Metz-Thionville and Briey mines produced about 15.6 million tons and 16.5 million tons of ore respectively. *Vide* A. Sömme, *op. cit.*, p. 222.

In the Moselle plain, along the edge of the plateau between Maizières and Thionville, lie the industries of the Metz-Thionville basin. With these are included the works of the lower Orne valley, which, from Moyeuve to Rombas, is crowded with iron and steel-works, coking-ovens, and railway lines. There are four parallel railway lines in the lower part of the valley. On both sides of the Orne, filling all the space in the valleys that is not occupied by factories and villages, are the *cités* of the miners and iron-workers. Stahlheim and Amnéville are large developments of this kind. Rombas has eight blast-furnaces and elaborate steel-works. It is the only establishment of German origin in this area. The Rombas works receive their ore from neighbouring mines by means of aerial railways. Moyeuve also has eight blast-furnaces. Here too are coking-ovens—a modern development in the Lorraine iron-fields¹—and large steel-works. Jœuf, the market town for the valleys, has nearly 10,000 inhabitants, for the most part miners and metal workers. The works here were the first in France to employ the Gilchrist-Thomas process. It was shortly after the founding of these works that important iron deposits were discovered in the Orne valley. Auboué, which adjoins Jœuf, has electrically worked forges. Hagondange, which makes finished steel products, lies at the foot of the Moselle escarpment; Uckange, farther downstream on the Moselle, where it approaches the escarpment, and Thionville, just below the confluence of the Fentsch, have blast-furnaces but no steel-works. The northern slopes of the valley of the Fentsch and the lower valley of its tributary the Algrange form a continuous industrial area from Fontoy to La Fenderie. There is little space for development, for the valley is narrow and steep-sided. The large steel-works of Rumelange, with ten blast-furnaces, and those of Hayange, with eight, are supplied from gallery mines in the valley sides and from deep mines in the interior of the plateau to the north. Hayange was the site of ancient hammer-works and was one of the first places to use 'minette' ores.

On the important railway junction of Thionville converge the line from Luxembourg and Belgium, that joins the river Alzette iron basin to the Sarre coal-field, and the lines from Strasbourg and Metz. The Moselle line to the Rhine, which was vital to Lorraine under German rule, as it carried iron-ore and pig-iron to the Ruhr district, caused Thionville to receive much attention from the Allied airmen during the Great War.

THE LONGWY IRON BASIN. North of Thionville the edge of the Oolitic outcrop swings round to the west and runs parallel with the southern edge of the Rhine plateau and its Ardennes

¹ Axel Sömme, *op. cit.*

extension. The Franco-Belgian-Franco-Luxembourg frontier follows the ferruginous sandstone outcrop of the lower Oolite, which here forms a belt of high, wooded country a couple of miles wide.¹ Thus Belgium and Luxembourg each have a share in the northern extremity of the iron-field. Two rivers drain this northern edge of the Oolite plateau—the Alzette, which winds east and then north, passing through the city of Luxembourg, and the Chiers, which flows west via Montmédy to join the Meuse above Sedan. On the divide between the two rivers and in the head-stream valleys of both we find the mines and metal-works of the northern or Longwy field. The mines of Ottange and Rumelange, close to the frontier, lie only three or four miles from the northern mines of the Thionville basin, on the plateau. They are also worked from shafts. Audun-le-Tiche, right on the frontier, shares a railway station between France and Luxembourg. Villerupt, close to the old frontier, at the head of a small branch valley, was developed by the French after 1872, when the frontier was so drawn as to include the mines of Redange and Russange in a salient of German territory. The mines of Hussigny and Godbrange, close to those of Redange, but on the other side of the narrow divide, lie at the head of a tributary valley of the Chiers. All these mines are gallery mines except those of Hussigny which are quarries rising in an amphitheatre tier above tier, for the iron deposits approach the surface here. The villages lie on the valley slopes, sometimes high up on the edges of the plateau. The deep, V-shaped valleys in the sandstone, as well as those cut in the Lias Clay, are densely wooded. The railways follow the valley bottoms. Iron and steel-works, constructed with French or Belgian capital, are found in every valley. Longwy, which has given its name to this iron-basin, lies on the right bank of the Chiers, about three miles below the junction of the Godbrange-Hussigny tributary. The fortress of Longwy (Longwy-Haut) lies at a height of 1,260 feet, overlooking the high-road; the modern Longwy-Bas has developed on either side of the bridge along the roads that climb to the plateau. The steep, wooded valley slope separates the two towns. Half a dozen iron- and steel-works lie on the converging railways in and near Longwy. They are some of the most important in France. We are here in the department of Meurthe and Moselle, which, although it contains but a small part of the iron-field, has doubled its population in the last fifty years. The ore of the Longwy basin is of the Upper Red zone,² and is so sandy and friable that it scarcely pays for transport, and must be utilized on the spot. The production of the basin in 1913 was 2·85

¹ Fig. 61.

² See p. 341.

million tons.¹ Nine miles below Longwy we reach the western extremity of the industrial region at Longuyon, the junction of the Chiers and Crusnes and of the railways from Luxembourg, Montmédy, and Metz. Here boiler-works and a hardware industry have developed along the left bank of the Crusnes.² This, combined with the proximity of the rapidly-developing Longwy district, has led to a corresponding increase in population.

Apart from these industrial valleys the Oolite plateau is monotonous ploughland. Small villages surrounded by apple, cherry, and plum orchards, occupy hollows at the heads of dry valleys where water is obtainable. Below, the Moselle vale continues broad and flat-bottomed, as far as Sierck, a little beyond which it crosses the frontier into Rhenish Prussia. Sierck holds a strategic position where the Moselle suddenly enters a gorge in the Shelly limestone. From this town the Moselle forms the frontier between Rhenish Prussia and Luxembourg.

SAULNOIS. Saulnois, as we have seen, begins in the Triassic Keuper marls, and its southern borders are drained by the Sanon and the Marne-Rhine canal. Gentle depressions occur here in the Lias deposits, caused possibly by the subsidence of underlying layers in the Keuper marls, due to the extraction of brine.³ It is the Seille that drains the greater part of the salt area. Early extraction, owing to lack of deep boring facilities, was perforce confined to the utilization of brine springs in the upper valley of the Seille. The Etang de Lindre is formed by damming up the head-waters of the Seille above Dieuse. Gallo-Roman settlements extended along the Seille and Petit-Seille; Salonnès, the Roman Salona, Château Salins, Marsal are evidence of the ancient exploitation of the salt. Unlike the Sanon deposits of pure rock-salt, the salt in the Seille basin must be extracted from 'salines', i.e. by solution and pumping. At Dieuse there are chemical works, dependent on the salt extraction.

In Saulnois the monotonous stretches of cornland, which occupy the clay soil, are relieved by a certain amount of viticulture and a good deal of permanent pasture. More cattle are reared here than in any other part of Lorraine. This is a modern development and has entailed the making over of considerable areas of grainland, where it is wettest and heaviest, to pasture. The western section of Saulnois and the region south and east of Metz—the Messin—is still mainly agricultural and under wheat,

¹ See Louis Ferasson : *La Question du Fer*, 1918, p. 85 et seq.

² All the iron-field, with the exception of the Nancy Basin, fell into German hands during the war of 1914-18. The mines were worked by them, and many of the iron and steel plants remained active, but there was a systematic destruction of plant, particularly that employed in making finished goods.

³ See p. 331.

although in the Messin also much arable land has been converted into pasture. Carp-fishing in the lakes of Saulnois has some importance, and the lake bottoms, after the draining and drying that is carried out every three years, are ploughed and sown with a variety of crops. Some of the lakes act as reservoirs to the Sarre canal and to the Canal des Salines.

THE SARRE BASIN ¹

We have now to consider the basin of the Sarre, which includes the Sarre Territory, a political and possibly an ethnographical conception, but having no effective geographical boundaries. The Sarre Territory includes the greater part of the worked Sarre coal-field.

THE SARRE. The Sarre rises in the Donon Massif, in the main water-parting of the Vosges and close to the head-waters of the Vesouze, in two main streams—the Sarre Blanche and the Sarre Rouge. A couple of secondary roads follow the two valleys upstream; they join and cross the ridge by the pass of Schirmeck, to which a road from Nancy also leads via Raon l'Etape. Schirmeck, about three miles in a direct line to the east of the pass, lies in the Bruche valley, or Breuschtal, which leads down to Molsheim and Strasbourg, twenty-eight miles away. The head-streams of the Sarre traverse the lonely forests of Turquestein and Abreschwiller and enter the Shelly limestone zone near Lorquin, once a Roman station where the road that followed the fertile limestone belt crossed the road from the pass of Schirmeck. Modern road and canal have shifted the *carrefour* to Heming. The change from the empty forest lands to the busy life and crowded villages is striking. Sarrebourg is the centre for this fertile region, and has a natural nodal position, for all the head-streams of the Sarre that drain the High Vosges converge in the neighbourhood of the town, and the road from Strasbourg via Saverne and Pfalsbourg, as also the railway and canal from the Zorn valley, pass through or immediately to the south of the town. From the north the line from Saarbrücken also converges. To the west of the town, on the Keuper marl, here covered by thick deposits of Quaternary sands, largely forested, lie the shallow lakes that feed the Marne-Rhine canal and the Colliery canal,² which unite some seven miles to the south-west.

This difficult belt of forest and lake played a rôle of some importance in 1914.

Once a walled city—the Pons Sarrivi of the Romans—

¹ The Sarre Territory was returned to Germany in 1935, but was put under French military control in 1945.

² See p. 486.

Sarrebourg is now a thriving market town, particularly for cattle. It lies on the linguistic frontier between German-speaking Alsace and French-speaking Lorraine, though in the town itself German is the dominant tongue. Formerly French was spoken in the old town on the plateau and German in the more modern town in the valley. Large barracks and a military aerodrome emphasize the relation of its position to the Rhine-Paris route via the Saverne gap. Sarrebourg was the stage in 1914 of one of the battles which ended in the retreat of the French from Upper Alsace and *Lorraine Annexée*, which they had invaded in the first days of the War, to a safer position near Nancy. The other decisive battle took place at Morhange on the Seille.

North of Sarrebourg the Sarre traces an undecided course along the edge of the grainlands of the Keuper marl, drawing its water from the Forêt de Fénétrange. The Canal des Houillères deprives it of some of its supplies. Its two tributaries Esch and Eichel wander through the low Triassic plateau of Shelly limestone, their banks dotted with villages at every mile, while to the east the dense agricultural population ends suddenly along the edge of the Bunter sandstone forest. North of the Zorn, the Saverne forest narrows to a width of three-quarters of a mile, and the last of the line of scarp villages overlooking the Zorn is within three miles of Saverne, but at a much greater elevation. The road that links Pfalsbourg with Saverne drops by a number of hairpin bends to the Rhine Rift valley. North of Pfalsbourg the fertile Shelly limestone zone is cut off by the widening of the sandstone forest of La Petite Pierre and Ingwiller. At Sarreunion the Sarre quits the Shelly limestone zone, which swings away to the north-east, and meanders in broad loops across the clay plain, through the woodland that covers the patches of Quaternary sand. Sarrealbe has salt-works, the salt deposits lying in the Shelly limestone below. The Solvay soda-works draw their raw material from this source. These deposits in very early times gave rise to a steady traffic. Straw-plaiting is a cottage industry which grew up on a basis of rye straw locally grown, but, as at Luton, the hats are now worked up from imported material, such as Manila palm-leaf fibre. Sarrelouis shares this industry, by which the peasant women occupy their winter evenings. Sarreguemines (Saargemünd), farther downstream, used to be famous for its beaver hats. To-day its chief industry is the making of bricks, tiles, and porcelain. Here the river Blies joins, forming the southern boundary of the Sarre Territory. The boundary skirts the northern edge of the French town of Sarreguemines, where the Canal des Houillères takes off

from the Sarre, and here the road and rail from the Rhine approach via Niederbronn. Road, rail, canal, and frontier now follow the Sarre northward for half a dozen miles to the neighbourhood of Saarbrücken, where the river enters the Sarre Territory proper.

THE SARRE TERRITORY. A mile or two above Saarbrücken the Sarre enters the south-west extension of the zone of Bunter sandstone which has been weathered into a series of south-west to north-east extending ridges, still heavily forested for the most part, though much clearing has followed the development of the underlying coal-field. The forested outcrop of Bunter sands extends south-westwards to the Bouzonville-St. Avold line. The Shelly limestone zone swings round it, overlooking it in a distinct escarpment, from which a fan of streams drain northwards and eastwards to the Sarre. To the north-east the zone of Bunter sands extends as far as Neunkirchen. Beneath the sands lies the Sarre coal-field, preserved in a depression of the Hercynian mountain system, limited to the north by the abrupt faulted edge of the Rhine plateau.

The Sarre valley narrows and widens with the bands of harder and softer rock. Saarbrücken lies at the point where the river, issuing from the Shelly limestone escarpment, opens out its valley and receives a couple of tributaries from the north. Here the bed of the river is sufficiently graded to make possible navigation by small craft, and here the St. Avold road, following the edge of the escarpment, crosses the Sarre. Saarbrücken, the bridge town at the head of navigation, grew up as an important collecting centre for Lorraine products (agricultural produce and salt). The outlet was northwards via Trèves. Since the development of the Sarre coal basin the movement of traffic has been southwards via the canalized Sarre and its lateral canal, and thence east via the Rhine-Marne canal.¹ Following the trend of the Hercynian folding which preserved the coal-measures, the rivers Soultz, Fisch, and Kaller, and the minor tributaries of the Rosselle, as well as certain tributaries of the Blies, facilitate the mining of the coal along the axis of the basin, as the Sarre valley itself does across the width of it.

The Sarre coal-field extends north-east to Birkenfeld, where it crops out at the surface, and dips gradually south-westwards in the direction of Pont-à-Mousson, where its existence has been proved at a depth of 2,587 feet.² The workable length of the basin is about sixty miles and its width about thirty. The coal is mined in the Sarre valley itself, between Saarbrücken and Sarrelouis and in the valley of the Rosselle, a left-hand tributary,

¹ See Fig. 99.

² *Coal Resources of the World*, Vol. II., p. 668.

and in the valleys of right-hand tributaries, between Saarbrücken and Sarrelouis notably the Fisch and Soultz and the tributaries of the Blies to the north of Ottweiler. On the French side of the frontier there are mines in the valley of the Merle, tributary of the Rosselle and in that of the Bisten, which joins the Sarre at Wadgassen.

Further west the dip of the strata takes the coal out of reach, but faulting brings it up again between the Metz-Château Salins road and Pont-à-Mousson. Hitherto it has not been deemed profitable to exploit this section of the coal basin.

Most of the Sarre Territory formed part of Rhenish Prussia. The worked basin extends, however, into the Bavarian Palatinate, where the Frankenholz mine remains to-day outside the Sarre Territory and French control. The output of this mine is about 400,000 tons per annum. In 1913 the output of the whole basin was about 17 million tons. Of this amount the south-west section in *Lorraine Annexée*, now French territory, produced in round figures 3·8 million tons. The average annual output for the Sarre Territory for the five years 1924-28 was 13·5 million tons, slightly above the 1913 figure.¹ It is interesting to note the increased output and the increased output per shift, due to improved mining equipment.²

The Sarre coal-field was granted to France by the terms of the Versailles Peace Treaty for a period of fifteen years as part compensation for the German destruction of the mines in the north-east of France. The French Government controlled the working of the mines (which previously were controlled by a Westphalian group), and the attached coke-ovens, for the benefit of the French nation, under an administration which went by the name of the 'Mines Domaniales de la Sarre', and which had its seat at Saarbrücken. The Sarre Territory, whose boundaries were fixed by the terms of the Treaty, was governed by a council appointed by the League of Nations. According to the terms of the Treaty, a plebiscite in 1935 decided that the Territory should return to Germany. Since 1919 the Territory has been so systematically Germanized, largely by the introduction of Germans from the Reich, that its permanent restoration to France seems unlikely.

The Sarre coal is about—

64 per cent bituminous caking coal.

¹ This includes the output of the Frankenholz colliery. *Statistique de l'Industrie Minière*, 1924.

² By 1934 output had fallen again to 11·3 million tons, some two million tons below the 1913 figure.

30 per cent flame coal with a high percentage of volatile matter, non-caking.

6 per cent poor quality household coal.¹

It has been a misfortune, from the point of view of the development of the iron and steel industry of Lorraine, that the Sarre caking coal, in addition to the disadvantages of containing a large percentage of ash, does not form good metallurgical coke. The coke made from it is very friable, and so does not stand transport well, and it cannot be used in the heavy charges of the modern blast-furnaces. The old-fashioned blast-furnaces that used the Sarre coal had to be small and specially designed to prevent the crushing of the coke. The larger modern furnaces used on the Lorraine iron-field had to import coke or coking coal to mix with the local product. This before and during the War was supplied in the main from the Rhur coal-field of Westphalia. To-day, as a result of the researches of the French technical staff, Sarre bituminous and volatile coals (*flammenkohlen*), after treatment, are blended in proportions of about 7 per cent to 13 per cent respectively, and produce a satisfactory metallurgical coke for which the demand is increasing.² Heinitz, two miles to the south of Neunkirchen, on the Blies, has important coal-distilling plant at the coking-ovens where this blending takes place. The gas and coking coal is worked mainly in the Soultz valley, near Dudweiler and Sulzbach.³

The workable coal of the Sarre basin occurs in about a hundred bands, for the most part less than three feet thick. In the Petite Rosselle mine, however, six miles south-west of Saarbrücken, in French territory, there is a seam eleven feet thick.

Of the mines in *Lorraine désannexée*, Petite Rosselle, which produces some good quality coal, has six collieries, employing 9,300 hands and producing 2·3 million tons. La Houve, whose coal is used for the generation of electricity, because it is of poor quality, employs 1,500 hands and produces ·3 million tons. The deep mines of l'Hôpital and Merlebach, belonging to well-known German iron and steel firms, employ 5,500 men and produce 1·1 million tons.

As in the other parts of the Bunter sandstone areas of Lorraine, the early industry was that of glass-making. Glass-works still function on the coal-field at Wadgasse and Völklingen on the Sarre, and at Sulzbach and Friedrichstal on the Soultz. Such iron-works as existed in early times were forges, using charcoal

¹ *Vide* Delpont, 'The Sarre Coalfield,' *Iron Trade Review*, March 14, 1929.

² *Vide* Delpont, *op. cit.*; also G. Eisenmenger: *La Lorraine au Travail*.

³ In 1928, 2·4 million tons of metallurgical coke were manufactured in the Sarre, an advance of 860 per cent on the pre-1914 output. *Statistique de l'Industrie Minérale*, 1924 and 1930.

fuel from the forests for smelting and local streams for power. Coal was quarried in a desultory way for domestic purposes as early as the fifteenth century. From the sixteenth century it was employed in the forge, though the profusion of local timber delayed the recognition of its value as a combustible. In 1776 the Prince of Nassau-Saarbrücken claimed the field and proceeded to exploit it. He also encouraged the establishment of steel-works near Saarbrücken.¹ In 1793 the territory passed to the French Republic. It was not until the nineteenth century that the deposits of coal were tapped by actual mines. The outcrop of coal was carefully mapped under Napoleon. The second Treaty of Paris gave the whole of the developed coal-field to Germany. After 1815 the mines were almost all exploited by the Prussian State. The Bavarian Palatinate owned two mines. As in the case of the iron-mines, so the annexation of the coal-mines by Prussia stimulated prospecting on the French (Lorraine Annexée) side of the frontier, where eleven new concessions were developed. After the Franco-Prussian War the frontier was extended to include once more the whole of the worked field within Germany. Although borings proved the extension of the coal-field south-westwards, no further development took place in Lorraine Annexée, for with the dipping strata the seams became too deep to work profitably. In the north-east, in the Bavarian Palatinate beyond Frankenholz the coal comes to the surface and is of such poor quality as to be almost worthless.

The pre-1914 production of the coal is shown in the Appendix, p. 506.

Since 1918 the distribution has not changed much as regards regions supplied, though the regions have changed flags. The most interesting difference is the increase in the Italian, Belgian, Luxembourg, and Austrian demand for Sarre coal and the decrease in the demand from Switzerland. In 1934, 4,370 million tons of coal (or of coke, briquettes, etc., reduced to their coal equivalent) were imported into France from the Sarre Territory.

The iron and steel industry of the Sarre Territory remained, to a large extent, under German control, though Luxembourg, Belgian, and French interest was considerable. In 1934 production of steel was in the neighbourhood of 1.9 million tons. The two iron- and steel-works of French Lorraine lie in the Rosselle valley below St. Avold, separated from the French collieries of the Merle

¹ See L. Gallois : 'Le Bassin Houiller de la Sarre' (*A. de G.*, 1919); also L. Gouvy : 'Le Bassin Houiller de la Sarre' (*Journal des Economistes*, October 1915).

valley by the small forest of St. Avold. Within the Sarre Territory most of the iron- and steel-works lie in the Sarre valley itself, between Dillingen, at the junction of the Prims, and Saarbrücken. The iron-ore for these works comes mainly from the Moselle basin. Before 1918 the German firms of the Sarre imported pig-iron in large quantities from the Moselle iron district. Since 1918, they imported a much larger proportion of ore and did their own smelting. This has increased the production of pig-iron in the Sarre Territory considerably, but not the output of steel. In 1928, 50 per cent of the Sarre pig-iron went to Germany; 23 per cent was worked up into finished and semi-finished articles within the territory. Of the steel, over half went to Germany and over a quarter to France.

THE MEUSE BASIN

The head-waters of the Meuse take their rise in Bassigny, not far from those of the Marne. We have seen¹ how greatly the upper basin of the Meuse has been restricted by the aggressions of the more vigorous Seine and Moselle. Only in the south and in the Chiers basin does it develop tributary streams in Lorraine. It draws a fan of tributaries from the forest-clad, sandstone ridge that borders the plain of Lias Clay, and its tributary the Vair drains the dip slope of the Shelly limestone rocks in the downs of the Monts Faucilles. These tributaries unite near Neufchâteau in the Oxford Clay vale, after traversing the plateau of Oolitic limestone, which they divide into separate blocks by their deeply-cut valleys. The upper Meuse forms the most westerly rib of this fan of streams as it flows along the foot of the main plateau receiving contributory streams from the springs at its base. Bassigny, like Xantois, is a fertile clay ploughland, for the Lias here has a thick covering of loam. The *pays* includes part of the Oolite plateau. Nogent-en-Bassigny actually lies in the basin of the river Marne,² but the name Bassigny appears only to belong to those sections of the plateau where the rivers have so eroded the limestones as to expose the Lias Clay in the valleys. The Oolite plateau in this region, dissected into blocks over 1,300 feet above sea-level, is very dry and sparsely peopled, for the iron-ore deposits do not reach south of Nancy, and is in the main given up to forest. The Lias Clay valleys between the upstanding limestone blocks are well peopled, however. The Meuse now cuts across the Oolite plateau and the Oxford Clay plain to enter the zone of Corallian limestone to the west, leaving the Moselle to hold the centre of the stage. We have seen how

¹ p. 333.

² p. 110.

stream. Neufchâteau is a small town lying on the slope above the valley-bottom of the Meuse, which here has a braided course. The old town lies high above the Sedan-Langres road. The convergence of important roads and railways—six railways and six national roads—would lead one to expect a centre of greater size, and the more so because the place had considerable strategic importance. The fact that it has remained so small is a reflection of another fact—that the Meuse valley, in its course through the Côtes, is both physically and economically a side-track. The river enters the Corallian limestone plateau at Coussey, and then follows a narrow, entrenched valley through waterless, wooded plateaux, almost devoid of inhabitants for eighty miles, to the neighbourhood of Mouzon. The flow of water is relatively feeble, although it is perennial, receiving its maximum rainfall from the south in summer, and in the northern part of its Lorraine course in winter. When the water table is high in the Corallian limestone there is a good flow of subterranean water into the Meuse valley. This is particularly so in the winter and spring. In the autumn, however, after the summer drought, lacking this supply, the water is apt to be very low. The valley floor lies over a hundred feet higher than that of the Moselle in the same latitude.

The main line railway, running from Mézières to the junction at Neufchâteau and following the edge of the flood-plain, now on the right, now on the left bank, brings but little life to the small towns and villages, particularly in the south, above the junction of the Rhine-Marne canal. Below this point the valley acquires a certain amount of activity from the facilities for transport offered by the waterways. One of the few assets that it possesses is the good building stone which is quarried in several places between St. Mihiel and Pagny, as at Commercy, Euville, and Lérrouville. Pagny produces cement limestone. Lime is exported for the iron districts and used locally for cement, which is exported in all directions—to Paris, to Châlons-sur-Saône, for example. Foug, in the Toul gap, profiting by the Rhine-Marne canal, is auxiliary to the Pont-à-Mousson industrial district and makes and exports iron pipes. Void sends lime to the iron-works of the Sarre Territory. Timber forms the other bulky export from the region. It goes out in the form of pit-props to the Sarre coal-field, of rough timber for constructional purposes to the north, of stove fuel to the neighbouring centres, such as Nancy. St. Mihiel exports large quantities.

A little above Sedan the Meuse is joined by the Chiers, which, as we have seen, takes its rise in the Longwy iron district of the plateau of Lorraine, passes by Longuyon at the extreme north-east of the iron basin, flows north-west to Montmédy, touching

the Belgian frontier at Torgny, six miles above that town. About five miles below, at Carignan, it follows a fertile strip of country in the Lias rocks at the foot of the Ardennes, and the agricultural population is relatively dense along this strip, where there are also important industrial establishments.

Sedan is the centre of a woollen industry which is said to date back to the thirteenth century and which was certainly flourishing in the sixteenth. It has persisted, in spite of the unfortunate position of the town near the frontier, which brought disaster to it in 1814, 1870, and 1914. The industry grew up in the short valleys drained from the edge of the Ardennes to the Chiers, and utilized the wool of the sheep that grazed in the uplands to the south. Sedan is the centre of the weaving industry, which is carried on also at Floing and Balan, villages to the north and south of the town. Spinning mills lie on the plateau edge, overlooking the Meuse valley, and in the Ardennes valleys draining to the Chiers, between Carignan and Sedan. In 1913 there were 2,193 looms and 105,000 spindles. The old town of Sedan lies on the edge of the Meuse flood-plain. It is surrounded by barracks. The manufacturing town lies on the opposite side (left bank) of the river and along the main road leading from the Meuse bridge north-east across the Ardennes to Liège.

Below Sedan the Meuse winds in great loops along the Lias Clay vale to Mézières, where it turns sharply northward to etch its way across the Ardennes in a narrow, winding gorge; but it is joined by the Sermonne, which flows towards it in the vale from the north-west. At the confluence of the rivers is an industrial agglomeration composed of the one-time fortress and now large modern town of Charleville, in a wide loop of the Meuse, the citadel and modern annexe of Mézières on the ridge-neck of a narrow loop to the south and a modern suburb to the south again. The situation of this group is best shown in Fig. 34.

Charleville-Mézières is a metallurgical centre based on the Lorraine iron-ores and coal from the Belgian coal-field. It receives pig-iron by the canalized Meuse (Canal de l'Est) and coal from Liège. The twin towns do not deal in heavy metallurgy owing to cost of transport, but have foundries and stamping-mills, and are engaged in making boilers, nails, hardware, etc. In the neighbouring Ardennes valleys, Cons-la-Grandville has forges and stamping mills, Villes-sur-Lumes makes nails, Vrigne-aux-Bois makes hardware. By the canal, Mohan, a suburb of Mézières, receives coal for its great electrical installation. All this region of the department of Ardennes suffered very heavily in the war of 1914-18. Fourteen thousand buildings were destroyed, four communes were wiped out. The department had 1,770 factories in

1914, of which 234 were destroyed and 528 gutted of plant and machinery. The slate quarries of the Ardennes valley of the Meuse were flooded. Everything had to be started afresh.

A salient of French territory follows the Meuse in its passage across the Ardennes as far as Givet. The canalized river meanders within its incised and winding valley. Villages and small towns are placed at every bend. Sometimes they occupy the isthmus, sometimes the outer and sometimes the inner curve of a bend. It is only where the river, by deepening its curves, has left terraces of alluvium on the bank from which it is receding that cultivation can be carried on. Then the towns and villages generally occupy positions on the bluffs overlooking these cultivatable slopes.¹ The river Semois, which joins the Meuse in its great loop at Mouthermé, exhibits similar incised meanderings and similarly placed villages. Apart from the foundries at Mouthermé and Fumay the Meuse towns of the French Ardennes have little industry except slate quarrying. This, however, is important. Rimogne, with Haray, in the Sermonne valley, Mouthermé and Fumay with Haybes produce about 28,000 tons of slates per annum. The Fumay district is the most important. *Givet*, in the acute angle formed by the Franco-Belgian frontier, is a little town, flanked by forts commanding the Meuse route into Belgium. It has a number of large tanneries along the riverside.

VERDUN. Although it is obviously impossible to attempt, in a work of this type, to point out adequately the strategic importance and functions of the various frontier features of the country, yet one cannot, in a study of the Meuse valley, but pause for a moment to consider the site of the greatest and most terrible struggle that the world has ever witnessed. It lasted with intervals of relative quiet from February 1916 to August 1917. The main geographical features involved were the Meuse route from the north, the Rhine-Trèves-Thionville route from the north-east which joins the line from Metz at Labry, and the route to Châlons-sur-Marne and Paris to the west. These routes gave the fortress of Verdun its modern nodality. The general defensive position was provided by the Côtes de Meuse, rising in the neighbourhood of Verdun from 1,100 to 1,300 feet, and at their foot the streaming, waterlogged Woëvre draining to the Orne. The strength of the position locally lay in the steep, interlocking bluffs of the plateau projecting into the valley of the Meuse and forming the extremities of short ridges directed east to west. These enabled Verdun to face northwards as well as eastwards. The limestone rock of the old fortress, strengthened

¹ V. de la Blache: *Tableau de la Géographie de la France*, pp. 66, 67.

by Vauban's fortifications, was excavated to form galleries, stores, and shelters. The little town of St. Mihiel, about twenty miles to the south of Verdun, occupies a position very similar in regard to local conditions to that of Verdun. The Germans were able to maintain a salient thrust westward into the line here during the greater part of the War. All the settlements of any size in this section of the Meuse valley are fortresses. Verdun, Mouzon, Void and Neufchâteau, and other smaller places all lie on roads which crossed the Meuse and led from the Paris or Burgundian basin to the Rhine.¹ These were all Gallo-Roman roads converging on Reims and Langres.

The longitudinal route that followed the Meuse northwards and through the Ardennes has always allowed of a traffic, more or less accentuated, with Belgium. Apart from these nodal points, the distribution of population in the Meuse region of Lorraine is closely allied to the distribution of springs and streams. In Bassigny the hammers on the streams became the sites of villages. The alluvial terraces along the main river above the flood area, traversed by short, clear streams from the escarpments, are also populated, and of course the bridges across the Meuse attracted more important agglomerations. To-day much of the forest still lies shattered and wasted. Villages whose names still appear on the maps are names only. 'Here stood such and such a place' is the sole and tragic indication of their former existence.

¹ J. Vidal de la Blache : *Etude sur la Vallée Lorraine de la Meuse*, p. 168.

PART II

ALSACE

We have sketched the geological history of the formation of Alsace in the introduction to the account of Lorraine, and we need only remind our readers that Alsace consists of a section of the Upper Rhine Rift valley and of the corresponding faulted edge of the Vosges Massif. These include the strip of plain, a hundred miles long, lying to the west of the Rhine between the foot of the Jura and the river Lauter, and the eastern slopes of the High Vosges, together with a small portion of the Low Vosges. To the north of the High Vosges and between the Moder and Zorn rivers, where the forested Bunter sandstone belt of the upland narrows, the boundary of Alsace projects across the water-parting to include a portion of the plain of Lorraine in the Sarre valley, with the towns of Sarrealbe and Sarreunion. This salient coincides with the former Imperial States of Sarrewerden and Lützelstein. It nearly isolates the Lorraine district of Bitche to the north.

Rhine and Vosges form effective boundaries, as do the heights of the Jura to the south. In the north the geographical frontier is formed by a belt of forested sands—the Bienwald—which lies just to the north of the Lauter. We shall see later that there is a natural economic division, into Upper and Lower Alsace, recognized administratively as the departments of Haut and Bas Rhin.

Apart from the broad facts that concern the general features of the Vosges and the Rift valley and those that concern the potash and petroleum deposits, the older geological formations affect but little the geography of Alsace. It is true that, on the slopes of the Vosges, especially in the Saverne bay, fragments of Triassic and Jurassic rock are exposed, owing to the multiple faulting of the edge of the Rift valley. Such exposures are important locally. At Istein, for example, a mass of Jurassic limestone has formed a serious barrier to the regular flow of the Rhine. But, with a few such exceptions, settlement and occupation are related to the disposition and nature of Quaternary deposits and recent alluvium only.

Like Lorraine, Alsace falls into north to south strips of

contrasting habitability. The controlling factors in the plain are soils, drainage, and water-supply. Owing to the enormous deposits of detritus in the plain the run-off is inadequate and the drainage ill-defined ; there are still large areas of marsh undrained among the water-meadows and *marais*. Some sections of the plain are just elaborate mazes of streams, canals, and drains. The higher parts of the Rift valley floor are formed by ancient alluvium, chiefly sands and gravels. These deposits are usually so porous that the water retires underground and only seeps out on the edges of the formations. Some of these patches are of great extent; e.g. the Hart Forest. The most fertile areas of the plain are those covered with loess. The result of the subsequent erosion of the loose material laid down on the floor of the plain has been a division of the land into strips of raised sandy and gravelly country alternating with low, marshy belts in which the Rhine and its tributaries meander and develop a network of watercourses.

The Rhine has never been able to deal satisfactorily in the southern part of the Rift valley with the enormous masses of heavy detritus, sands, gravels, and stones brought down from its upper Alpine course. The sinking of the Rift valley floor, which continued intermittently until recent geological times, prevented the river from scouring and distributing this glacial material which comes to it during every period of flood. The result has been an elaborately braided course, a multitude of channels, constantly changing. With the straightening of the course of the Rhine all these deserted meanders, belonging to various periods in the river's history, remain in the flood-plain as backwaters, marshy channels, or swamps, full of reeds and inhabited by wild-fowl. The low islands between them are covered with a marsh forest of willows, alders, and poplars, for the waterlogged soil and subsoil are too stony and gravelly to be brought under cultivation, even if the summer floods did not make this impossible, so that the present banks of the river are uninhabitable. Skirting the flood-plain, and rising with a steep edge above it, is a low terrace of sandy land. Here, at the points where the ancient meanders of the Rhine touched the edge of the terrace, are small settlements, now deserted by the river, but linked together by a high-road which follows the edge of the terrace above the marsh. West of this strip of higher ground lies the flood-plain of the Ill, intersected by a broad and ill-defined series of watercourses which occupy an all too great area of the Rift plain. Patches of higher land rise here and there above the *ried*, as the ancient marshes of the Rhine and Ill are termed. These again are often comprised of porous material which is too

dry for cultivation and so is given over to forest. The Ill marshes, unlike those of the Rhine, have, to a large extent, been drained and brought under cultivation. Still farther west we come to the terrace lands at the foot of the Vosges. Here we reach the more fertile section of the plain, for the covering of loess which blankets ancient alluviums and Tertiary and older sedimentary rocks alike, is of great natural fertility, and the rainfall here is sufficient to make irrigation unnecessary. These loess-covered terraces, following the foot-hills of the Vosges, continue up the valleys and carry with them a belt of settlement and prosperous agriculture. Behind Strasbourg the rolling loess country fills the whole width of the plain. Above the cultivated terraces of the Vosges foot-hills rise the Vosges forest lands on the archæan and Triassic rocks, with beech on the lower slopes and conifers on the upper spurs. Above these again are the highland pastures of the Hautes Chaumes, the flat-topped moorlands of the summits which are common to Alsace and Lorraine.

In addition to these successive strips of contrasting country, we must draw attention to the hill country of the south, in which the waters of the Ill take their rise, and which includes the northern edge of the Jura and is known as the Sundgau—the south land. The valleys of the Sundgau, with their limestone subsoil and their warm, calcareous slopes, are very fertile, particularly for the cultivation of the vine. The shoulders of the hills provide good pasture.

Apart from the distribution of soils and subsoils, the main factor in the development and utilization of the plain of Alsace would appear to be the river systems. The Rhine, however great its economic significance may be in Alsace, is remote from the life of the agricultural population. Its catchment area within Upper Alsace is small—just a small comb of streams rising at a level of about 1,300 feet in the Sundgau. These streams do not reach the Rhine on the surface. They disappear from view beneath the glacial gravels of the Hart, which for about thirty miles, to the latitude of Colmar, forms a barrier to the surface water as well as to settlement. Such water as reaches the Rhine on its left bank, between Basle and the latitude of Sélestat, reaches it by subterranean channels. In upper Alsace the Rhine is only directly significant as a frontier. At present, whatever may be the future developments, it is only through the port of Strasbourg that Alsace is concerned with the Rhine, so we will postpone our consideration of that great waterway to a later section of the study of Alsace.

THE ILL. The real artery of the Alsatian plain is the river Ill, which collects all the Alsatian waters that flow from the

High Vosges and does not deliver them up to the Rhine until that river has passed Strasbourg. Its combined lateral water-courses occupy a zone as wide as that of the flood-plain of the Rhine itself. The Ill rises at about 1,800 feet at the foot of the Mont Terrible in the Sundgau. On leaving the last of the west to east longitudinal valleys of the Jura, its waters, together with the Talbach and Largue, draw to the north-west in a direction parallel with that of the upper Doller and the upper Moselle. These lines accord with the general trend of the drainage towards the pre-Rhine,¹ which flowed through the Belfort gap along the line of the Rhine-Rhône canal to the Rhône depression. At Dannemarie the rivers, reaching this natural trench, flow north-east along it to Mulhouse, tapping the south-eastern Vosges drainage on the way. At Mulhouse the Doller comes in from the Bâlon d'Alsace, and six miles farther north, at Ensisheim, the Thur, from the Col de Bussang and the Col de Bramont, sends part of its waters to the Ill. The Ill here is attenuated because so much of its water is drawn off or intercepted by canals. In addition to the streams named, a multitude of waters, rising in springs on the edge of the Vosges, stream across the plain to the Ill. The main stream of the Thur, however, accompanied by the Lauch, which brings its contribution from the forested Bâlon de Guebwiller, flows parallel with the Ill along the edge of the Vosges escarpment to Colmar. The line Colmar-Andolsheim-Neuf Brisach marks the northern edge of the alluvial gravel that bears the Hart Forest and its outliers, Rothleiben, Kastenwald, and others. North of this line the zone of the Ill and its parallel tributaries widens. The Fecht comes in on the left at Illhäuseren, somewhat impoverished by loss of water to the Lauch by the ancient canalized channel of the Logelbach, which diverges opposite Colmar. The Weiss drains to the Fecht the waters of a group of lakes that lie just below the crest of the Hautes Chaumes.

On its right the Ill is accompanied by streams and artificial drains covering a zone three miles wide. These rise on the northern edge of the Hart gravels to the east of Colmar. The largest of them is the Blind. This section of the Ill basin, now partly drained and cultivated, though in part still forested, is an ancient swamp known as the *ried*. The Illwald and the forest of Colmar are conspicuous between Colmar and Sélestat.

North of Sélestat a broad area of uninhabited marsh receives Vosges water, which it ultimately parts with to the Scheer. At Strasbourg the Vosges waters converge as they approach the

¹ See p. 262.

Rhine. The Bruche (Breusch) enters the Ill at this point. Between Bruche and Scheer the Vosges scarp streams have formed another *ried*, now criss-crossed with drainage channels. North of the Bruche there is the same streaming of waters from the Vosges scarps, but here the land descends in terraces between the highland (in the Saverne bay) and the *ried*, which is limited to a narrow strip between Bischwiller and Reichstett, traversed by the Zorn. North of Hagenau a bay of lower land covered with a thin layer of alluvial gravels is again marked by forests and a streaming of surface waters. This is the great forest of Hagenau. Its streams are collected by the Sauer shortly before the confluence of that river with the Rhine. The Lauter, draining the southern Low Vosges, enters the plain at Wissembourg. It forms the frontier between Alsace and the Bavarian Palatinate. We see then that, apart from the areas that have been artificially drained, the Ill plain is very marshy and is not well adapted for agricultural settlement.

The upper Rhine plain is no better endowed than the Ill lowlands. In the south a narrow belt of cultivatable land about a mile wide, lying between the Hart Forest and the flood-plain carries the national road and a string of small villages.¹ Huningue, the bridge-head suburb north of Basle where the Huningue canal takes off from the Rhine, with St. Louis and Village Neuf, also on the canal, may increase in importance if and when the great French canal scheme for Alsace materializes.² Neuf Brisach, one of Vauban's fortresses, an important bridge-head, greatly strengthened under the German occupation, guards the Rhine crossing by road and rail between Colmar and Freiburg. A score of villages lie along the road that links Neuf Brisach and Basle. South and south-west of the Hart Forest a double line of villages, a couple of miles apart, follow a water output on the edge of the upland. Each pair bears the same name, and they are distinguished by the prefixes Le Haut and Le Bas (Ober and Nieder), e.g. Ober and Nieder Michelbach. The villages are small and the district purely agricultural. The forest land between the Ill and the Rhine has but half a dozen villages all told and practically no isolated farms. Münchhausen is a canal-bridge settlement. North of the Colmar-Neuf Brisach line the porous, forested, glacial drift, devoid of surface water, is succeeded by more recent alluvium, varying in character, but for the most part less permeable than the more ancient sands and gravels. Here the forests have long been invaded by settlers, and a score of large villages are evenly dotted over the plain which narrows northward as the Ill approaches the Rhine.

¹ Fig. 65.

² p. 490.

West of Erstein the populated zone shifts to the west of the Ill on the edges of the *doab* between the Ill and Scheer.

The upper Ill tributaries, on the other hand, which drain the Sundgau proper, have relatively wide valleys whose slopes are densely settled owing to the fertile loess that covers the gravels and to the excellent water-supply from springs and wells. The spurs between the valleys rise to some 1,100 feet above sea-level and are, for the most part, wooded, especially the west-facing slopes, those facing east and receiving more sunshine are well cultivated and largely under the vine. Here the forest has been pushed back to the summits of the hill spurs.¹

Altkirch and Dannemarie, the latter in the pre-Rhine trench drained by the Larg, serve the Sundgau as centres of exchange. Altkirch has the advantage of being on the railway which ascends the Ill valley to Ferrette (Pfirt), perched on the most northerly edge of the Jura. It has about two thousand people engaged in cotton weaving.

The 1,000 foot contour marks the edge of the Sundgau alluvial plateau which runs northward from the edge of the Jura to a point at *Mulhouse*. This town of about 92,000 people stands in an advantageous position on a mound at the extreme northern edge of the plateau overlooking the Ill. Its earliest commercial and industrial relations were bound up with the Ill navigation. Later it developed a front on the Rhine-Rhône canal. To-day it stretches to the Doller in the north-west, where the lay-out of the town bears witness to an early effort of town-planning to accommodate the textile workers, and southwards beyond canal and railway for a distance of over a kilometre. It is a busy manufacturing town, the centre of the textile industry of Alsace, and specializes in calico printing. The Alsatian industry originated in Mulhouse in the middle of the eighteenth century, with the printing of Indian muslin for the Paris market. Double-track lines link it with Belfort and Besançon, with Strasbourg and Basle. Its situation, economic and strategic, in relation to the Trouée de Belfort and the upper and middle Rhine valley, is reflected in its history—as a free Imperial city in the fourteenth century, as a part of the Swiss confederation in the seventeenth century, and as a daughter of France by free choice in the eighteenth century. After a period under the rule of Germany from 1871 to 1914, the town changed hands twice in the Great War, to return to France finally with the Treaty of Versailles 1919.

¹ The prevalence of forest in the Sundgau is due to the open Belfort Gap which allows the penetration of Atlantic climatic influences from the west. Once in the shelter of the wall of the Vosges we find all the lower slopes up to about 1,300 feet terraced for cultivation, while forest darkens the heights above.

The Rhine-Rhône canal has ensured for its industries cheaply transported coal, and the Ill and Doller an ample supply of water. It employs about 11,000 people in cotton mills, about 5,000 in the wool industry, and nearly 2,000 in the silk industry, besides between six and seven hundred in hosiery. Some 3,000 persons are engaged in printing on textiles and 600 in dyeing and finishing.

North of Mulhouse a string of settlements follows the Ill to Colmar. Immediately north of Mulhouse the Forêt de Nonnenbruch, until lately a silent unbroken stretch of forest, is the busy scene of the Alsace potash mining. Some fourteen mines are situated in the shallow valley sides and are joined by mineral lines with the Colmar-Mulhouse railway.¹ Here also, based on the salt-mining, are developing dyeing and chemical works, subsidiary to Mulhouse. A number of modern *cités*, or miners' colonies line the road that skirts the woods between Mulhouse and Ensisheim. The village of Wittenheim boasts the earliest mine in this rich deposit.

Colmar, unlike Mulhouse, does not lie on the Ill but above the Lauch, near its confluence with that river. It belongs to the series of settlements that line the Vosges scarps. It is an important road centre, commanding the road from the passage of the Rhine at Neuf Brisach via Munster to the Col de la Schlucht, where it crosses the north to south Rift Valley route. This position explains its former prestige as capital of Upper Alsace and its present status as *chef-lieu* of the department of Haut-Rhin, although it has a population of less than half that of Mulhouse. A little above the town the Lauch waters mingle by artificial irrigation channels with the Thur. A branch channel affords the town communication with the Rhine-Rhône canal, and it is joined by rail and high road with Mulhouse. Nevertheless it has not been drawn into the circle of that busy centre. Rather it has developed quietly a group of industries of its own, and, somewhat isolated by the great *rieds* to the north, east, and south-west, it has retained much of its medieval quaintness. The industries of Colmar have developed along the Logelbach, which joins the Fecht with the Ill. A variety of textiles are manufactured—woollens, cottons, silk, and artificial silk—and there are dyeing and finishing works, employing six or seven thousand persons. Markolsheim and Turckheim, in the Colmar radius of influence, have cotton- and woollen-spinning factories, and Turckheim specializes in silk-dyeing. Munster, in the Fecht valley, a dairy-farming centre, has been industrialized from Colmar. Guebwiller, in the entrance of the Lauch gorge, on the

¹ The output in 1936 was 2,123,000 tons.

other hand, and Thann¹ on the river Thur, come definitely within the radius of activities of Mulhouse. They have important textile industries and are examples of the linking of the industries of the Vosges valley towns with those of the plain. In addition there are important quarries in the Bunter sandstone. Along the foot of the Vosges, agriculture goes hand in hand with the textile industry, the dual occupation making for economic stability in the countryside.

North of Sélestat the population is distributed in three strips, separated by belts of *ried*: the Vosges foot-hill belt, served by the railway between Sélestat and Molsheim, with the vineyards and tanning and leather industries of the Barr valley; then a narrower belt to the east accompanying the high road and railway from Sélestat to Strasbourg, with the town of Erstein; and the third between Ill and Rhine, following the high-road and canal. North of the Bruche and Molsheim the *rieds* disappear, giving place to the undulating plain of loess-covered alluvium which spreads like a fan south-west, west, and north-west of Strasbourg. The Ill valley industrial zone sends tongues of denser population across the rich, agricultural loess belt that hugs the edge of the Vosges and along the valleys that penetrate into the heart of the upland. The Vosges torrents were the vital factors in the settlement of these valleys. Almost every village lies on a stream. Even where the valleys form broad *thalsolen*, as in the instances of the Fecht and Bruche, the village is usually placed where the meandering river, or a branch thereof, approaches the steep side of the valley. A very large proportion of the villages of both plain and upland valley have water-mills. Some, like Mutzig on the Bruche near Molsheim, have three or four. Where narrowing of the valleys induces swift currents there are many water-mills without villages, as, for example, in the Wasselheim gorge. Apart from the water-power which controlled the establishment of the early factories and which is still used in a large number of mills to supplement steam power, a situation on the stream was necessary for washing, dyeing, and bleaching purposes.

Apart from the industry which is thus closely attached to the valley bottoms, the population of the Vosges foot-hills is mainly agricultural. Aspect decides to a great extent the use to which the valley slopes shall be put. The higher terraces and the Vosges foot-hills are devoted to vine cultivation, and wines of recognized merit are made at Rouffach, Ribeauville, Riquewihr, Egnisheim, and Bergholtz in Upper Alsace and at Barr, Gertwiller,

¹ Thann suffered heavily from bombardments during the War, its dye-works especially.

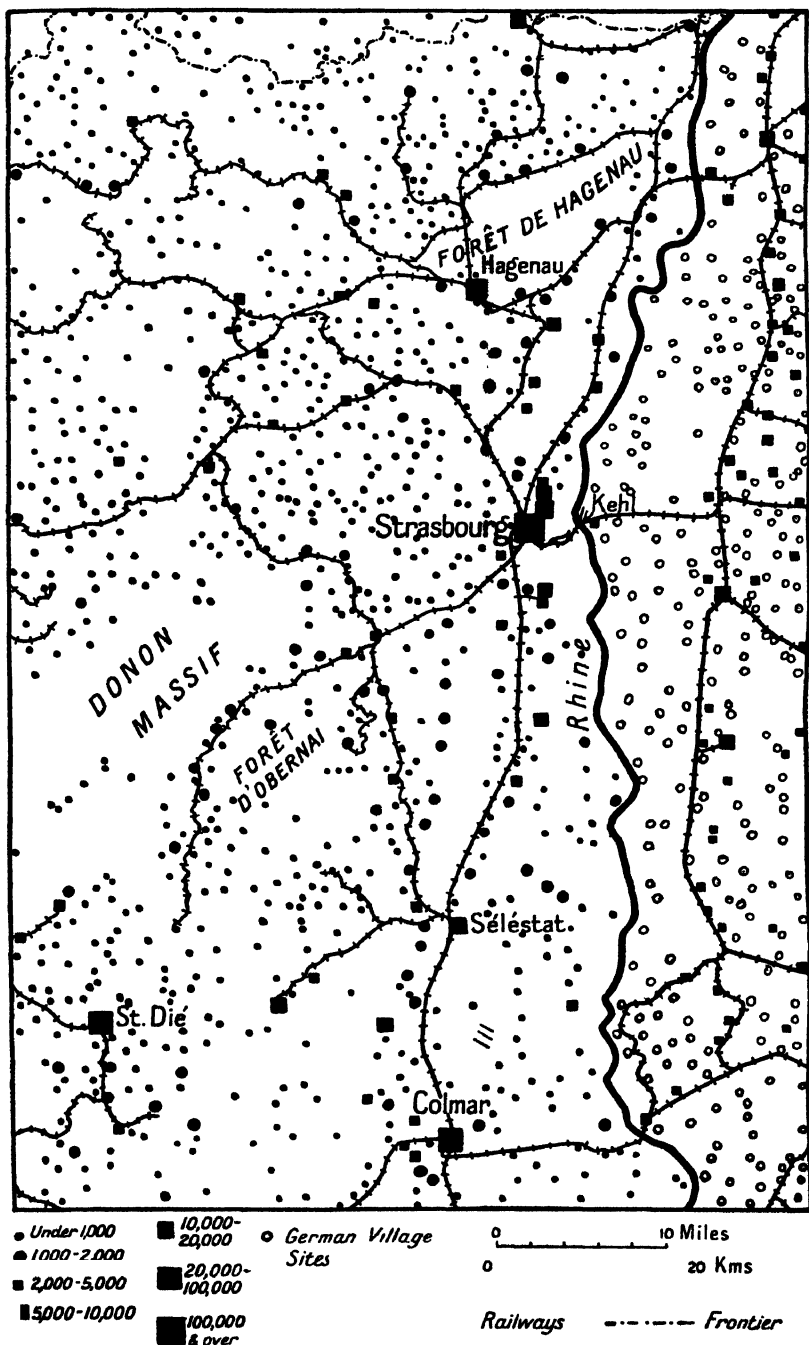


FIG. 65. DISTRIBUTION OF POPULATION IN ALSACE. NOTE THE RIBBON DISTRIBUTION IN THE SOUTH AND THE EVEN DISTRIBUTION ON THE LOESS PLAINS BEHIND STRASBOURG.

Obernai and Molsheim in the valleys of the Barr, Boersch, and Bruche in Lower Alsace. The vine-growers combine the production of high quality vines with that of more ordinary but heavily producing types, in order to minimize the risks which the sharp changes of temperature of a continental climate entail. There are some 4,000 vine-growers in the two Alsatian departments.¹

Below the vine slopes stretch fields of grain broken by hop gardens and orchards which stretch down to the water-meadows of the Ill plain. The arrangement of the cultivation belts reminds one irresistibly of that of the Côtes d'Or.

North of Strasbourg the ancient flood-plain widens again. Swamp forest stretches between Ill and canalized Rhine, among the deserted Rhine meanders. A broad stretch of *ried*, between three and six miles wide, is separated from the Rhine Forest by an alluvial belt of higher ground which carries the main road to Lauterbourg, and a continuous line of large villages—Wantzenau, Gambsheim, Offendorf, Herrlisheim, Drusenheim, and so on to Selz. The population on this alluvial strip is much denser than on the similar strip south of Strasbourg, because of the activity engendered by the main railway from Strasbourg to the north; but the Rhine banks still remain desolate. The *ried*, on the other hand, is to a large extent reclaimed. A network of drainage and irrigation canals intersect the water-meadows, and the edges of the one-time swamp are closely cultivated. North of the Zorn the cultivation of tobacco and hops, which to the south is only sporadic, becomes intensive and spreads along the edge of the forest of Hagenau. It is tending to oust the cultivation of peas and other vegetables grown for the canning industries of Strasbourg, Colmar, and Sélestat. The soil is light and sandy, but hops, tobacco, asparagus, and potatoes thrive on it. Bischwiller is an important hop centre, and Hagenau, on the Moder, is the great market for hops. Hop-growing was only introduced in the beginning of the nineteenth century, when plants from Czechoslovakia were imported, but the cultivation has been so successful that it dominates the agriculture of the Rhine plain north of Strasbourg. The yield is high and the product competes with that of Kent and Czechoslovakia. Alsace provides about one-twelfth of the world's hops. The intensive cultivation of this region has been greatly aided by the proximity of the Lorraine iron-works and of the Alsace potash deposits. The forest of Hagenau, stretching east and west for about eighteen miles across the Rift valley, formed the boundary between the Franks and the Allemanni. It still forms a five-mile wide zone

¹ Armand Meggél: *L'Alsace*, 1928, p. 31.

devoid of population, though it provides work and wealth for the Haguenau district, to which commune about half of it belongs.

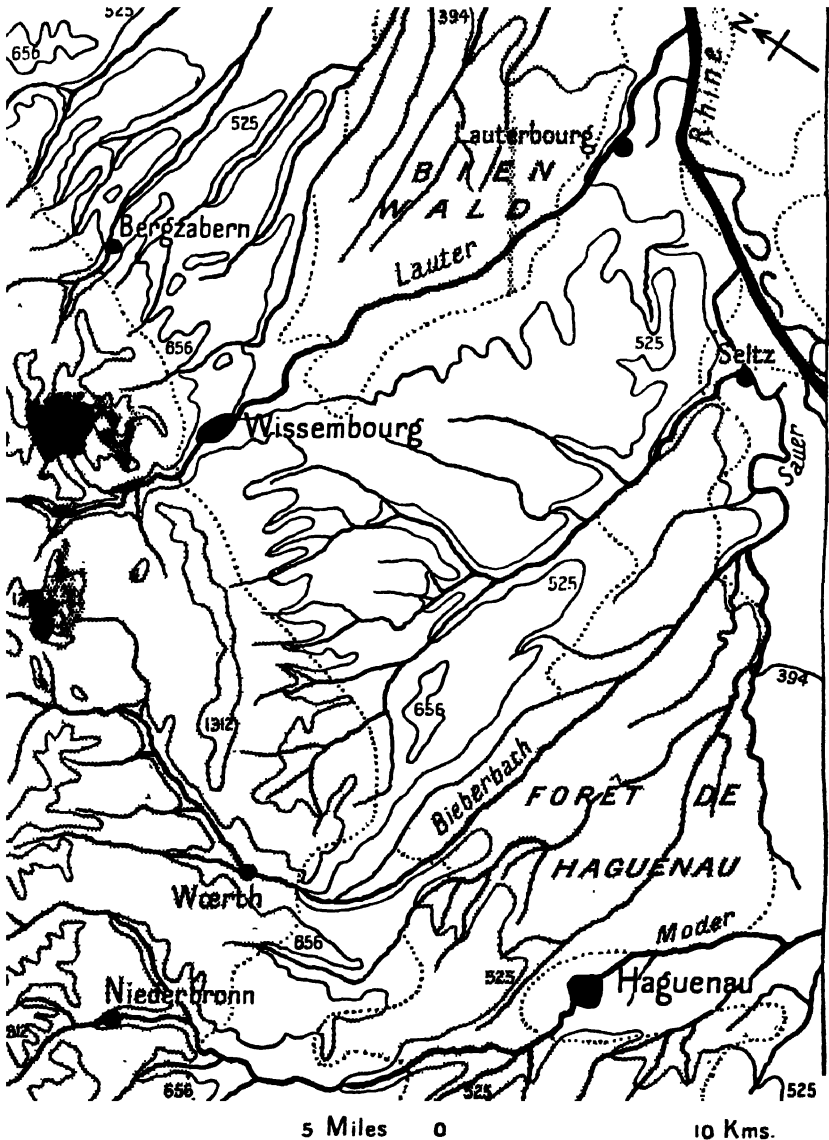


FIG. 66. THE UPLAND AND LOWLAND FORESTS OF LOWER ALSACE

Its presence is due to a great expanse of alluvial sand ; it is planted mainly with pine, which precedes and protects subsequent

plantations of oak in this system of forestry. The forest is drained by innumerable streams to the Sauer, which joins the navigable Rhine at Münchouse. North of the Hagenau, the great forest of Bien stretches across the Rift Valley. Its southern edge is drained by the Lauter, which forms the boundary between Alsace and the Bavarian Palatinate. The forest is the effective boundary, for the Lauter is not a stream of any importance. Lauterbourg, at its mouth, has a harbour on the Rhine, which is a useful adjunct to Strasbourg at times of low water. It distributes coal, coke, and briquettes to the textile works of Alsace and to the iron- and steel-works of Lorraine, and exports petrol and iron-ore to its small hinterland of Wissembourg and Sont, wedged between the two forests. Its modern coal equipment enables it to handle 60,000 tons of coal per annum. Hops and tobacco again form the main crop in this small but rich agricultural area. Horse-rearing is important in the water-meadows of the Lauter valley, and maize becomes progressively more common. Wissembourg, just within the French frontier, lies in an almost enclosed basin of the Lauter, where the river emerges from the Low Vosges. Its good position as a road centre is neutralized by its position on the frontier, north of which the economic life naturally centres on the German town of Landau.

West of the plain the Low Vosges are bordered by a patch of Tertiary rocks. These contain, in a depression about forty miles long parallel with the Rhine, the oil deposits associated with the village of *Pechelbronn* (pitch spring), where they were first exploited. Biblisheim and Morsbronn have wells belonging to a Dutch firm, and borings stretch in a line north-eastward between Morsbronn and Cleebourg. The output of the wells is not great, they only provide about 9 per cent of the consumption of oil in France. Soultz-sous-Forêts, as its name implies, developed in connexion with salt springs.¹ To-day its main occupation, apart from an important horse and cattle market, is in oil refining. The most important product is lubricating oil.

Behind the Tertiary belts there is a narrow outcrop of Shelly limestone, which adds to the fertility of the Sauer and Zugel valleys. The change is sudden to the steeply rising-forest mass of the Low Vosges, with its narrow, V-shaped valleys and dense pine woods relieved by the startling crimson-red of the Bunter sandstone crags. The textile industry has no importance in the Low Vosges, but the streams were utilized for forge-hammers in earlier times. To-day there are foundries (e.g. Zinswiller) and small iron-works producing a variety of goods. South of Bouxwiller, just where the plateau begins to rise to the High Vosges,

¹ Salt is associated with petroleum deposits.

the forested Bunter sands narrow to a neck a mile wide. On a ridge, capped by Shelly limestone, between the Zorn valley and that of its tributary the southern Zintzel, stands Pfalsbourg on the road which leads west to Sarrebourg, Lunéville, and Paris and east to Strasbourg. For three miles the road runs west to east along the ridge, and then zigzags down the scarp, a drop of 660 feet, to Saverne. The fortress of Pfalsbourg became less important with the construction of the railway through the

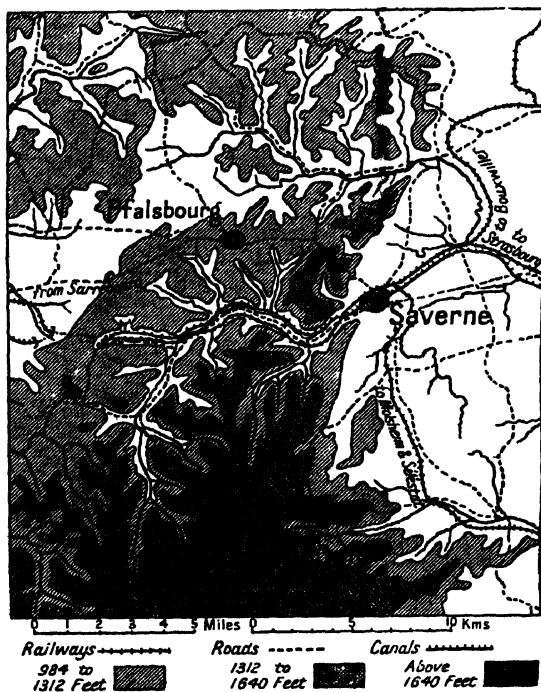


FIG. 67. THE SAVERNE GAP. NOTE THE DEEP ZORN VALLEY GIVING ACCESS TO THE LORRAINE PLATEAU ACROSS THE NARROWING BELT OF FORESTED SANDSTONE HIGHLANDS.

narrow gorge of the Zorn, which ensured the development of Saverne both as a garrison town and as a market centre. The population of Pfalsbourg is only 1,581, that of Saverne 8,036, although Pfalsbourg stands at the junction of important national roads.

The Vosges. In upper Alsace the frontier between Alsace and Lorraine follows the crest of the Hautes Chaumes. These forested slopes rise gently on the Lorraine side from the densely peopled

plateau of St. Dié¹ to the crest, at about 3,200 feet, whose summits are grass-covered and afford summer pasture for sheep and cattle. The descent on the Alsace side is precipitous, owing to a line of faulting. At the foot of the fault scarp a trench is followed north-east and south-west by the Liépvrette and the Béchine-Weiss streams respectively. Southwards, towards the Col de la Schlucht, a series of glacial lakes store water for the Fecht and the Weiss tributaries. Between the Bonhomme and the Bâlon de Guebwiller the crest is followed by a road at an elevation of between three and four thousand feet. From it tracks or roads lead off down the valleys on either side. These valleys are thickly populated in comparison with those of the Petits Vosges farther north, when we consider their elevation of 2,000 to 3,000 feet. This is due in part to the ease of communication with the prosperous St. Dié basin and also to the development of the textile industries in all the valleys. Ste. Marie-aux-Mines is closely allied industrially with St. Dié and Lunéville in Lorraine. Its factories are concerned chiefly with the manufacture of woollens, and there are important bleaching and dyeing works. It also has a *passementerie* and embroidery industry. The town lies on the Liépvrette at an altitude of 1,180 feet and has a population approaching 7,000. Ste. Marie is only fifteen miles from St. Dié in Lorraine, via the Col de Ste. Marie, and communication between the two centres is frequent. There is also a close liaison with the textile valley of the Béchine-Weiss and with all the smaller valleys between Sélestat and Colmar. The close relation with Lorraine is emphasized by the fact that French is spoken on the side of the stream that is in communication with the *col* and German on the other. The completion of the railway between St. Dié and Strasbourg via the Col de Saales brings the Bruche valley also into closer touch with Lorraine, and a line of rail will, before long, join Ste. Marie-aux-Mines with St. Dié. Ribeauville, employing about 5,000 people in the district, Thannenkirch, Liépvre, Ste. Croix-aux-Mines are all small textile manufacturing centres with a number of factories using the streams for water-power. The industries work mainly for Ste. Marie-aux-Mines. Soultzmatt, on the Olmbach, has the distinction of important schappe silk-works. It spins waste silk from the Lyons industry and sends the thread to be twisted at Basle. Barr has important hosiery-works, making knitted goods of cotton, wool, silk and artificial silk.

Under the German occupation much planting of pines took place, and much of the high moorland was thus put to a more profitable usage than that of rough pasture. Timber is brought

¹ See p. 337.

down by slides or, more recently, by road. In addition to the small saw-mills of the valleys there are one or two large establishments that not only absorb the oak, ash, beech, and pine wood produced locally, but import from the Baltic and North America. These mills produce chiefly constructional timber and barrels. Much upland pasture remains, however, and serves to feed large numbers of milch cattle between May and September, and cheese-making in the *marquaireries*¹ is important. Munster cheese has a wide reputation. There are about 200 of these mountain dairies in the Vosges. Communication between the valley communes that hire the summer pastures is kept up by means of a donkey transport. The valley communes are occupied in dairy-farming and textile industry. The villages are usually in two parts—the old burg perched on the valley slope and the industrial annexe stretched along the river bank. The silver-mining that gave its name to Ste. Marie-aux-Mines, and Ste. Croix-aux-Mines has long since died out in the Vosges. The rivers are all important in the economy of the valley life. They turn the innumerable mills that provide power for sawing, paper, and pulp-making, and for the ubiquitous looms which are found in every homestead, and for the spinning and weaving factories employing each from 100 to 500 employés that succeed one another along the valleys. These spindles and looms work for the factories on the Logelbach at Colmar, or for the upland textile centre of Ste. Marie-aux-Mines.

We see, then, that the Alsatian High Vosges have a farming and industrial life combined. The dairy-farming benefits from the capital accumulated by the spinning and weaving that takes place on the farm, and many, especially of the younger folk, go down to work in the factories each day and return to the farm at night. This means a condition of prosperity which compares favourably with that in the forests farther north, or that in those western parts of the Central Massif where there is no cottage industry to augment the poor return from agriculture. The upland and the higher valleys are linked by several reasonably good roads with the Meurthe basin and the Romance element is strong, especially in the district that works for Ste. Marie-aux-Mines and communicates with the rest of France by the Cols de Ste. Marie and du Bonhomme. Lorraine seems to thrust in a wedge between Upper and Lower Alsace (Haut-Rhin and Bas-Rhin). The boundary between the two provinces corresponds with that of the two ancient dioceses of Basle and Strasbourg. After the Franco-Prussian War the desire of the Alsatian manufacturers to avoid the loss of French custom led to the transference

¹ German *molkeriei*: cf. *fruitières* in the Jura, *vide* p. 273.

of works across the water-parting. Since the recent War the link between the two provinces tends to strengthen. Modern road transport and the abolition of the frontier customs, to say nothing of the joining up of the military railway lines that stopped short at the heads of the valleys, either by motor-bus or by an extension of the rail, are all playing a part in this development.

THE RHINE AND STRASBOURG

We have reserved consideration of the Rhine and Strasbourg till the latter part of the chapter because, in the first place, the development of the great port of eastern France is intimately connected with the development of the navigable highway, and in the second because, although both river and town are integral members of the geographical entity of Alsace, yet both the one and the other have an international significance which leads one to view them with a broader background than their immediate geographical surroundings.

THE RHINE. The Alsatian Rhine holds so important a position as a line of frontier and as an international river, and the development of potentialities in the latter capacity are the subject of such great international concern, that one feels that it merits special attention here.

Between Strasbourg and Basle the Rhine is essentially an Alpine river. The gradient is steep, the drop between these two towns being 330 feet. We have seen how the Ill captures and bears off to the north of Strasbourg the tributaries from the Vosges that trend towards the Rhine. Much of the Black Forest drainage also is prevented from reaching the Rhine above Strasbourg by the piracy of the Neckar. So that the régime of the Rhine in this reach of its course depends to a large extent upon Alpine conditions.¹ The river is frequently depicted on small-scale maps as a single broad stream. This gives a false idea of the nature of its course, and is largely responsible for the mistaken idea that it is a natural means of communication uniting the peoples on either shore. On the contrary, in this section the Rhine is by nature a barrier. It enters the Rift valley a broad current 650 feet wide, with a gradient of 1/1000. An examination of the large-scale map reveals the fact that, in spite of the swiftness of the current, the river has built up innumerable islands in its course, some formed by deposits of sand and gravel brought down in enormous quantities in flood-time from the Alpine reaches, some carved out of

¹ Twenty-six per cent of the annual water flow of Alpine rivers is reckoned to be stored in the form of snow reaching the rivers only in the summer. In the Black Forest the amount stored is very small.

the banks by the river when in spate. Before the first regularization of the river it was wont to follow now one channel, now another, constantly changing its main channel and silting up old ones, constantly building up new shoals or islands. The meanders of the Rhine were not those of a sluggish stream that has completed the grading of its course and is in the act of building up its bed above the level of the surrounding country. It is still a mountain river, and the irregularities of its course are due to the sudden and violent floods that occur and to the enormous amount of detritus that the river receives from its Alpine head-streams. As one stands on the bridge at Strasbourg and watches the river swirling beneath one's feet, one realizes that, flat and low as the banks may be, the Rhine here is still a wayward mountain torrent. Moreover, banks and islands are clothed with a dense growth of willows and poplars. Though from the top of the cathedral, at Strasbourg, the eye may sweep the lines of the Vosges and of the Black Forest, the Rhine is invisible, hidden beneath its awning of swamp forest. True it is that in medieval times even this section of the Rhine was much used for transport, owing to the bad state of the roads and the unsettled conditions. But its utilization was a *pis aller*, from the point of view of both transport and safety. Small boats used to come up by sail or were towed up. But it took a hundred men to tow a small barge against the current and the journey took days to accomplish. Horses could not be satisfactorily employed on account of the irregular and uncertain state of the banks. The Rhine of the Rift valley to-day is tame in comparison with its vagaries in earlier days. Abandoned channels, reclaimed islands testify to conditions when flood waters spread nearly twice as wide as they do to-day.¹ Down to 1764 little was done to curb the lawlessness of the river, except the erection of a few dikes. Then the State of Prussia, at the instigation of Frederic the Great, carried out considerable works of reclamation, and, by means of dikes and cuttings, kept the waters of the Prussian Rhine to their prescribed channels and reclaimed for pasture and cultivation considerable areas of land. As a result of important regulation works, begun in 1817 and continued through the greater part of the nineteenth century, the main stream was forced to follow a middle course, which winds, not without sharp bends, amid a tangle of side streams, islands, and gravel banks. As far as the navigability was concerned, however, this regularization did not help much. The straightening and confining of the river in the interests, at first of the riverain population and later of navigation, meant a shorter course by fifty miles, and in consequence a much steeper gradient,

¹ Vide Haelling, G., *Le Rhin*, p. 69.

a swifter current, and renewed erosive activity, so that upstream navigation became much more difficult.¹ To-day a diked channel exists for the whole length of the Rift valley Rhine, but it is only with the aid of powerful tugs that the upstream passage can be made. Even so, traffic above Strasbourg is only possible for those months of the year when the river is high. The maximum depth is generally reached in June. Between September and April in most years navigation is interrupted almost completely by the low water due to the freezing of the Alpine sources and by the accumulation of ice in the river. The ice may be due to actual freezing of the surface in the slack water, or to the freezing of mud and water in the bed of the river, which then rises to the surface; it may be due to the masses of ice brought down from the highlands by the Neckar and other tributaries which become frozen. Ice is very dangerous, because by piling up against vessels it may cause them to break away from their anchorage, or by forcing itself beneath their keels it may cause them to founder. Therefore, when there is a danger of ice in quantity, shipping leaves the river and takes refuge in winter harbours. Ice is often accompanied by fog, which is a further danger to navigation. From time to time a summer drought *comme renfort de potage* will close the navigation for the rest of the year.

In the years 1915, 1916, and 1921, for example, the people of Basle had it brought home to them that no port could prosper whose communications were so uncertain. Again, in December 1925 cold weather resulted in low water (four feet seven inches at Strasbourg-Kehl), and navigation was further blocked by floating ice. This was followed by a sudden thaw and heavy rains, which resulted in very high water and great floods, conditions equally disastrous for shipping. Autumn and winter rains, which help to maintain a sufficient flow in the lower Rhine, are only partially effective above Strasbourg, owing to the fact that the Ill tributary collects and carries off most of the waters coming down from the High Vosges and only delivers them to the main stream below the city.

The swiftness of the current means that the consumption of fuel per ton-kilometre of traffic amounts to 0.30 or 0.40 Kg. on the waterway, which compares very unfavourably with the 0.03 or 0.04 Kg. consumed on the railway on a similar gradient.² In 1922, which was an exceptionally good year as far as the river

¹ The effect produced by shortening the course of a river is the same as is produced by an elevation of the land or sinking of the base level.

² It is interesting to note that the German shipping firms which, before the war of 1914-18, managed to bring the annual tonnage reaching Basle by river up to nearly 100,000 tons, were subsidized by the Federal Government. Mannheim had a tonnage of 10,000,000 tons before 1914.

traffic to Basle was concerned, the consumption of coal formed seven-tenths of the cost of transport. Yet another difficulty has been opposed to the development of Rhine navigation in this section. The existing bridges are few, it is true, but they are all low. At Strasbourg the Kehl bridges offer a serious danger to navigation at high water, and a hindrance to the development of the port of Strasbourg. Navigation up to Strasbourg is now possible for large barges for the greater part of the year under normal conditions, since a more or less permanent channel has been dredged to six and a half feet.¹ Above Strasbourg the river can still hardly be considered navigable even to-day from an economic point of view. Only for a few months as a rule in the summer is the river navigable for the smaller type of Rhine barge, and then often with only a lightened cargo. Moreover, at Istein there is a bar across the river, due to an outcrop of Jurassic limestone, which is a great hindrance at low water, to say nothing of the gravel which is torn from the banks in the upper Rift valley and re-deposited between Rheinau and Strasbourg in ever-shifting banks. The seven pontoon bridges cause delay in opening and closing and present danger in periods of flood. The ferries which used to ply in the upper reaches of the Rhine have been suppressed, thereby improving navigation facilities, but aggravating the barrier nature of the river.

Conditions are by no means always satisfactory even below Strasbourg. The formation of gravel banks continues, and as these are apt to shift and change their shape during every period of high water, the maintenance and marking of the channel is costly and difficult and the navigation of the river can only be trusted to highly skilled and experienced pilots. The floods in the end of September 1925, for example, caused a change in the channel between the port entrances of Strasbourg and Kehl. Even with the regularization completed, it must not be supposed that regularity of shipping is secured, for the engineers cannot control the vagaries of the weather. For example, in the summer of 1925 the water-level was three to four and a half feet below normal, making it impossible for barges to come up with full loads. In the end of December of that year, on the contrary, cyclonic conditions caused rain to fall heavily over the whole basin of the river, a rise in temperature in the Alps and a rapid melting of snow. The Rhine overflowed throughout its course. Vessels had to be taken into sheltered basins. Several big barges were sunk. Tugs could not get under the bridges unless they were able to let down their

¹ *N. du R.*, January 15th 1926. The regularization of the river to Strasbourg was completed in 1912.

funnels, and most of them were unable to struggle against the violent current. Quays and warehouses were flooded and an enormous amount of damage was done. In 1924, on the other hand, the water at Strasbourg dropped to four feet, much to the profit of Mannheim. In 1929, owing to intense cold, ice closed the Rhine traffic from the 10th of February till the middle of March; and, in the following summer, drought decreased the channel depth till in October barges could only be loaded to 44 per cent of their capacity. (Haelling, *N. du R.*, January, 1930.)

STRASBOURG. The position of Strasbourg is an interesting one. The town has a site of strong nodality. It is situated at the junction of the Rhine-Marne canal and the river Ill. Like the rest of the Alsatian towns it is not a Rhine-side growth. It originated in a stronghold commanding the road which led via the Col de Saverne, from the Rhine and from the Rhine valley highway, over the Vosges at their narrowest point, into Lorraine, and so into Burgundy and thence to Paris; and in the opposite direction via the Kinzig valley to the north German plain. In the faulted mountain wall to the west the little river Zorn has cut a deep cleft, which to-day is followed more or less closely by road, rail, and canal leading from Strasbourg to Toul and Nancy. Behind Strasbourg the rifted walls of the Rhine plain give back in a wide semicircle, narrowing the sparsely-peopled forest lands of the Vosges. The bay of undulating lowland thus formed in the edge of the Rift valley, covered with a fertile blanket of loess, has made Strasbourg the market centre of one of the most fertile areas of the whole Rhine basin. Hop gardens and orchards and fields of wheat and sugar-beet stretch away to the foot-hills of the Vosges.

The place was probably at first a Celtic settlement situated on an island enclosed by two arms of the Ill. In Roman times a stronghold on the Ill, it was named Argentoratum. It became a Roman military station with a residential suburb. On it converged the great Roman highways from Rheims and Mainz. Under the Allemanni, Argentoratum became Stratisburgo, the strong place at the junction of the paved Roman roads. The town rapidly assumed importance not only as a market at the road junction but as a port on the water highway of the Ill, by which it communicated upstream with Colmar and downstream with Bâle. In medieval times the depth of the Ill was sufficient for water communication with Mulhouse and Sélestat. With the construction of canals in the nineteenth century¹ the nodality of Strasbourg increased. The construction of railways, which

¹ Rhône-Rhine Canal, 1841; Marne-Rhine Canal, 1853; *vide* P. Léon, *A. de G.*, 1902, p. 68.

took advantage, with the slight deviations that engineering improvements made possible or gradient made necessary, of the same natural route as the roads, were able easily to converge on the now important centre of commerce. They speedily became serious competitors of the canals, and finally reduced them to a moribund condition. It was not till a water link was provided with the navigable Rhine that the canals, even though subsidized, could be resuscitated.¹ But, as we have seen, Strasbourg, although happily placed from the point of view of nodality and of the fertility of the country-side, was not well placed so far as the navigability of the Rhine was concerned.

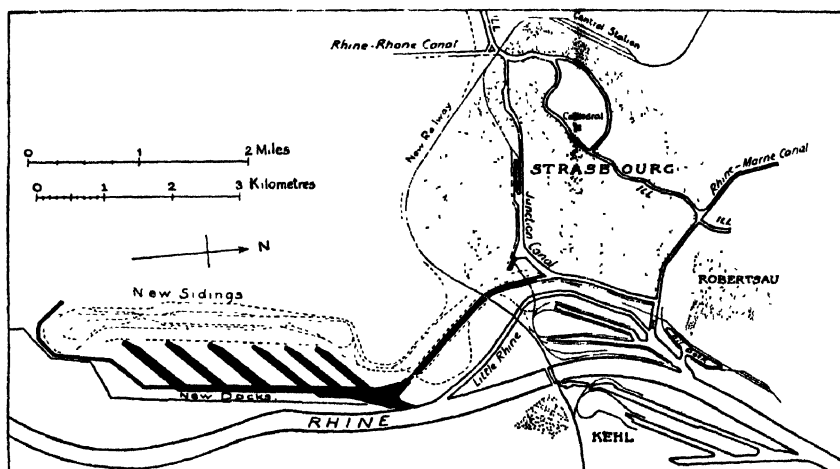


FIG. 68. THE PORT OF STRASBOURG SHOWING RECENT DEVELOPMENTS IN BLACK. NOTE THE POSITION OF THE OLD TOWN ON THE ILL, AND THE CANAL CONNEXIONS WITH THE ILL AND RHINE.²

The first Rhine port of Strasbourg stood at the junction of the Rhine-Marne Canal and the river. In 1907 two large basins, built in anticipation of the extension of the Rhine regularization upstream from Mannheim, were constructed and formed the beginning of the modern Rhine port. The improvement of the Rhine to procure a depth of six and a half feet between Sondernheim and Strasbourg, which was begun in 1907, became effective in 1925; but it must be remembered that in winter as a rule barges can only carry half a load. In 1919 the Rhine-Rhône canal was improved so as to be able to carry the 280 ton *péniches* to navigate the French canals. Under German rule Strasbourg was chiefly important to the Reich on account of its strong

¹ For an account of the Rhine Canals see pp. 485-91.

² A lock, opened in 1934, gives access from the Rhine to the dock basins of the Ramparts, Austerlitz and Vauban, used by potash, coal and electricity companies as well as armaments works.

strategic position behind Metz. During the war of 1914-18 the Germans found it convenient to utilize the port for the coking of Ruhr coal, which heretofore had been coked in Westphalia and transported by the Moselle railway to Lorraine. Much iron-ore also came to Strasbourg by rail to be shipped to Westphalia. After 1918 the completion of the regularization works and the internationalization of the river gave an impetus to the development of the Rhine port and great efforts have been made to establish a traffic connexion with Antwerp.¹

In spite of its development on river and canal it must not be forgotten that modern Strasbourg owes far more to rail than to water transport. Its main function as a receiving and distributing centre is based on the rail connexions that serve the canal and river ports. Its industries depend on rail quite as much as on water transport.

Relatively cheap coal, either from the Ruhr or from the Sarre, has made possible important electricity works. Strasbourg supplies some 340 communes in the Bas-Rhin department. In this function its own electricity works are supplemented by hydro-electric power from Switzerland and also from the Vosges. The coking of imported coal has continued and increased. Milling of local and imported grain, which reaches Strasbourg by river since 1913, is an important industry. The owners of the big mills in the port, having lost their pre-1914 German market, acquired interests in the milling industries of the major French ports. Engineering works have sprung up. A well-known firm of motor manufacturers has established works there, and cars are made at Molsheim on the Bruche and at Niederbronn in the Moder valley to the north of the town. In addition to these large-scale industries Strasbourg has notable alimentary industries—canning of fruit and vegetables, making of *pâtés de foie gras*, chocolate, farinaceous foods, etc. A semicircle of little market towns, lying at the junction of the Vosges with the plain and connected with Strasbourg by rail and canal, are rapidly developing industrially. Reichshoffen, for example, makes railway material.

Modern Strasbourg has concentrated on port and railway development. Since 1918 improvements have been actively carried out, of which perhaps the most noteworthy are the new goods station and railway sidings. A petrol wharf and grain elevators have added greatly to the efficiency of the port. A new port constructed to the south of the town, is linked by a junction canal capable of carrying Rhine barges, with the old port in the north. This affords an alternative and safer, albeit slower route.

¹ An interesting modern development is the shipment of Dutch coal from the new coal port of Maasbracht on the now canalized Meuse.

for the Rhine traffic and will have the advantage of avoiding the Strasbourg-Kehl bridges over the Rhine, which do not allow enough clearance when the water is high. Doubtless these bridges will eventually be raised, but the cost for the time being is prohibitive. This scheme of port development, which has been carried forward so vigorously by the French, is allied to a more grandiose scheme for the construction of a Rhine lateral canal (*le grand canal d'Alsace*) which shall eventually link up with the port of Basle via the new Kembs canal and with the Rhine-Rhône canal.¹

The westward hinterland of Strasbourg has been greatly extended since the restoration of the annexed provinces to France. The abolition of the Vosges tariff frontier and the improvement of canal communication with Basle gave a spur to the trade of the port, which theretofore had been handicapped by the very natural preference given by German firms and the Baden railways to the ports of Mannheim and Ludwigshafen for distributing to south Germany and Switzerland. As we have seen, the traffic between Westphalia and Lorraine used the Moselle route and brought but little grist to the mills of Strasbourg, so that it cannot be said that the port lost much by the change of frontiers. Since 1926 it has been administered as an autonomous entity apart from the city.

The Rhine traffic of Strasbourg is still largely of a transit nature and consists of the movement of bulk goods.² Imports upstream are mainly coal, in the form of coke or coking coal, grain, and lignite briquettes in order of importance; the coal and briquettes coming chiefly from Germany and the grain from Rotterdam and Antwerp. This last-mentioned commodity varies greatly from year to year, according to the French harvest. Petroleum is an upstream import of growing importance. Downstream the port receives practically nothing, which is unfortunate, seeing that thus the power supplied by the current is wasted. Its chief exports are iron-ore, which is sent both up- and down-stream,

¹ See p. 490.

² Traffic of Port of Strasbourg, 1936, in million tons

	EXPORTS	IMPORTS	BY RIVER	BY CANAL	TOTAL
R. Rhine	1.93	3.20	5.13	—	} 7.42
Rhine-Rhône C.	1.16	0.13	—	1.29	
Rhine-Marne C.	0.55	0.45	—	1.00	

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but chiefly down to Westphalia, and potash fertilizer and soda, which goes in the main to Holland and Belgium. The raw cotton for the textile industries of Alsace and Lorraine is imported by rail, chiefly from Le Havre. Cotton does not take kindly to water transport, first because, being a valuable cargo, it can afford to pay for the advantage in speed and safety offered by railway transport, and second because the navigation conditions of the Rhine are at their worst in the winter months, when cotton is being moved. Efforts of Antwerp to divert the traffic have not so far been successful. There has been a notable increase in the proportion of exports in relation to imports since 1918. In 1913 they were only 16 per cent; in 1936 they comprised 49 per cent.

The population of the town (181,881) has more than doubled since 1866.

We have described the two geographical regions of Alsace and Lorraine. Let us now consider for a moment their relation to one another in so far as such relation has a geographical background. What are the ties that link them? Natural lines of communication are north and south, and therefore have no binding influence. In the earliest days, probably the pastoral industry of the moor-tops and the ancient trackways that followed the ridges, avoiding forest and marsh, brought the two areas into contact. Later Gaulish and Roman roads, utilizing the crossing at Strasbourg and the valley-way at Saverne to reach Trèves, formed connecting links. Farther south the Rhine formed so complete a barrier that southern Alsace looked south-west and west towards the Vosges routes and the gate of Burgundy; a trend that was later emphasized by the inclusion of Alsace in the bishopric of Besançon. Strasbourg has always been more an international than a local centre. The division into Upper and Lower Alsace is a natural one. It is only with the modern development of rail and water communication that Strasbourg has dominated the whole of Alsace. And even to-day Mulhouse counts far more in Upper Alsace than the administrative centre. Strasbourg has become in an important sense the door for the industrial region of Lorraine only since its return to France. As we have seen, the interchange of coal and iron-ore with Westphalia took place via Thionville and the Moselle valley, partly because of the difficulty of navigating the Rhine in its Alsatian reaches, partly, possibly, for political reasons. With improved navigation facilities (1912) the Germans found it convenient to utilize the port and its communications with Lorraine. There seems to be no doubt that the traffic between Lorraine and

Westphalia will be resumed in full, whatever may be the development of trade liaisons with north-east Flanders and the north-east coal-field of France, and that in it Strasbourg will play an important rôle. Communications between Lorraine and north-east France have always been relatively difficult. If and when the Sarre district returns to Germany, it will be interesting to see by what route it maintains contact with the Rhine. Improved railway communications across the Vosges will emphasize liaisons that already exist between the Alsace and Lorraine industries. If the great French scheme for the development of a deep-water lateral canal ever eventuates, Strasbourg will become a French national port of considerable significance; and if, by means of hydro-electric development, the textile industries of Upper Alsace are further distributed in the plain, Strasbourg will become more definitely the focusing point of both provinces.

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PART III
ECONOMIC GEOGRAPHY

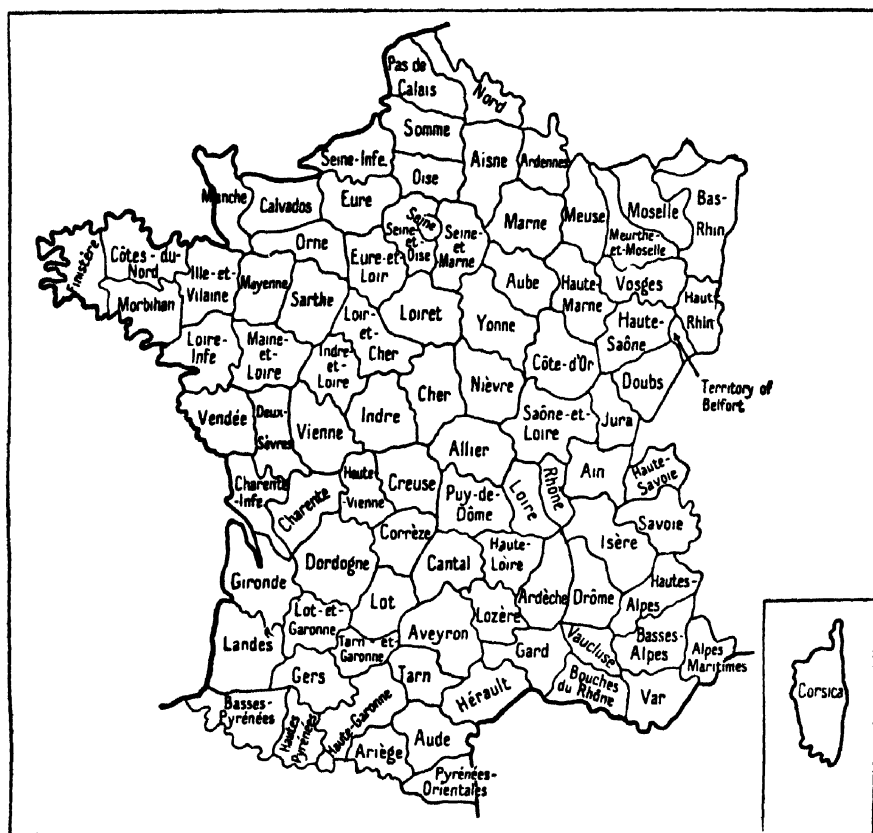


FIG. 69. THE ADMINISTRATIVE DEPARTMENTS OF FRANCE

(This map is for use with the distribution maps, Figs. 70-78)

PART III

ECONOMIC GEOGRAPHY¹

CHAPTER XII

AGRICULTURE

GENERAL CONSIDERATIONS

DESPITE the entry of France into the ranks of the great industrial nations of the world, her population is still 50 per cent rural,² and she still can be to a very large extent self-sufficing from the point of view of food-supplies.

(The division of a great part of the land into small holdings has been inimical to the improvement of cultivation by machinery, but small holdings have meant the intensive application of labour and skill and the economic application of fertilizer.) The re-aquisition of Alsace greatly aided French agriculture in respect of the last. Agriculture has, however, during the last fifty years, been undergoing a slow revolution. It has been going through the same stages as in this country, but with a difference. As M. Faucher puts it, '*Le vieux fonds agricole se renouvelle, se rajeunit, ne disparaît pas.*'³ Changing conditions have altered the balance in the distribution of capital and energy bestowed by the peasant in the economy of his farm. When improvements in transport made possible foreign competition in grain, the French farmer quickly reacted by reducing the acreage under grain and by concentrating on the rearing of animals for meat.⁴ With the development of the refrigerating system in transport, the competition of imported frozen and chilled meat was experienced, and to-day there is a marked change in the direction of rearing cattle for dairy purposes, fresh milk being the one large-scale commodity that, up to the present, cannot be transported across the seas. Higher wages and greater social amenities have for long

¹ Note.—The information in this section refers to conditions up to 1938. For a summary account of the period 1939-47, see Appendix II.

² In 1931 just over 7½ million people (i.e. over one-third of the 'gainfully employed' population of 21·6 millions), were engaged in agriculture.

³ D. Faucher : *Le Rhône Moyen*, p. 524.

⁴ L. G. Michael : 'Agricultural Survey of Europe—France' (*U.S.D.A.*, 1928).

been draining the village communities of their young men.¹ The war of 1914-18 served merely to accelerate the tendency to decrease the area of cereal land in favour of fodder crops and permanent pastures, and to concentrate on the production of milch cattle and meat cattle rather than on that of draught cattle and sheep. For the depletion of the man-power of the country has affected the rural population far more than that of the towns.² This tendency was combatted by State interference in the form of subsidies and quotas.

Sheep-farming is exacting as regards labour, whether the sheep are reared for general purposes, for wool, or for milk as in the Causses. Skilled shepherds are becoming difficult to find, as in England.³ The rearing of cattle is tending more and more to concentrate on the areas of intensive cultivation, where it has for long been important and where it forms part of an interlocking scheme in which industrial crops and fodder crops bear a close relation to meat production, dairy-farming, poultry, and pig-keeping. The upland pastures are being devoted more and more to the raising of young cattle, which pass to the agricultural lands for fattening. This process will, however, be retarded by the electrification of the countryside which is going on apace, and which is encouraging the association of industries related to pastoral agriculture, such as the making of chocolate and condensed milk and other foods, and of galalith and other lactic products. This condition of things is already highly developed in the Jura.

On the other hand, the decrease of acreage under cereal crops must not be taken as evidence by itself of decreased production, for there has been a noticeable improvement in the yield per acre of most crops in France, owing largely to a greatly increased use of artificial fertilizer. The re-acquisition of Alsace and Lorraine Annexée has cheapened the use of basic slag and potash for the French farmer, and there has been a great development of recent years in the fabrication of superphosphates from phosphates imported from North Africa. The same thing applies to diminution in head of cattle. It is noteworthy that both weight of carcass and yield of milk have increased in cattle and sheep.

¹ The return to the farmer for agricultural produce is calculated by Ogburn and Jaffé to be less than 1 per cent (op. cit., p. 489).

² Ogburn and Jaffé (*Industrial Development of Post-War France*) reckon that about one-eighth of the 'gainfully occupied' rural population were lost to agriculture through the war of 1914-18, and we must add the large number of disabled men who are a burden rather than an asset to agriculture.

³ A minor factor in the decrease in sheep- and cattle-rearing in the uplands is the enclosing of mountain pasture for purposes of afforestation. The diminution in area of mountain pastures need not be a serious hindrance, for it has been demonstrated that these pastures are capable of great improvement. (See p. 272.)

There is then a return to intensive mixed farming, but of an enlightened type, very different from the primitive methods of earlier days, when, owing to lack of communications, the peasant had to try to satisfy all his needs on the farm.

With the return to mixed farming of an intensive type on the better agricultural lands there will naturally be a gradual abandonment of the poorer land to rough pasture and even to waste. In the uplands, where the farms are to such a large extent left to the care of the women, this will be even more so. On the other hand, with the constantly increasing use of artificial manures and the care that is now being bestowed on the high pastures by draining and careful cropping, these pastures will be able to carry more sheep and cattle per acre and so lessen the wastage of energy in man and beast. The fabrication of cheese, for which France is famous, will continue, for high prices can be obtained for these specialized commodities abroad; but this side of the dairy industry will be exploited more and more for export to the large towns and abroad while the import of mass-produced cheese from America and Australasia for consumption in the industrial areas increases. In agriculture, as in industry, France excels in 'specialities' in which long tradition, cheap individualized labour, and a high average of intelligence and skill among the rural population all play a part.

The remarkable development of the *primeur* industry in modern times is an interesting example of the alertness and resourcefulness of the French farmer in adapting his methods to changing conditions. When the market for his grain and meat and wool threatens to disappear he throws himself with characteristic energy into the cultivation of fruit, vegetables and flowers for the big centres and for export abroad, as well as for the perfume and canning industries that depend upon his produce for raw material. In his efforts he is materially aided by the administrative authorities, who have done much to encourage him by irrigation and by establishing centres of instruction and research. The railways have not been slow to take advantage of this relatively new industry, and have co-operated in the provision of cheap and rapid transport for these perishable goods, just as they have lent themselves to the modern requirements in the sheep-rearing industry by conveying the sheep to the high Alps in the summer.¹ Improved road service is also an important factor in collection and distribution of these products to-day, and one of which the French farmer has been very ready to take advantage.

¹ This change was made partly with the object of preventing the spread of cattle disease, and for a time a veto was placed on the transhumance of animals.

FORESTS AND ORCHARDS

France had 10·7 million hectares under forest in 1938, that is, about 19 per cent of the total area. Except, possibly, for the lowlands of the Mediterranean coasts and the loose sands of the dunes, there is no part of France below the snow-line which, if left to Nature, would not be clothed with forest. The forest would be mainly of the deciduous type and would vary with the physiological humidity of the soil, from stunted thicket to tall forest trees. Deciduous forest land on well-drained plains is apt for conversion into agricultural land, and so we find that most of the forest has disappeared. Where it remains, it exists generally for one of three reasons : either the land is so high and exposed as to be too bleak for cultivation, or the soil is too infertile or too difficult to work owing to the type of underlying rock, or again the land may be too rugged or too steep or too inaccessible for cultivation. We find accordingly that forest remains on the bleak uplands that form the rim of the Paris basin, facing the prevailing winds, particularly on the steeper valley-sides, as in Argonne and Barrois and on the Plateau de Langres. All the steep slopes of the Auvergne and Cévennes valleys are forested. That the hill-tops are usually devoid of forest may be due largely to the agelong use of the more level summits for pasturage. Again, forest occupies the areas where the subsoil is composed of coarse sandstones, such as the regions of Bunter sands on the flanks of the High Vosges and covering also the whole of the Low Vosges. Patches of Tertiary sands or Quaternary sands also are usually covered with woodland if the sand is at all coarse ; thus we find large areas of wood in the Triassic Clay plains of Lorraine, in *La Champagne humide*, in the Rhine plain, even in the Paris basin where Tertiary sandstones overlie the clays or limestones, e.g. the forest of Fontainebleau. The cold, wet Gault Clay and the equally cold, dense soils of the clay-with-flints carry forest, e.g. the forest of Mormal. The loose, shifting sands of the Landes offered an economic return only to afforestation. For these areas of infertility the forests have only as competitors the cattle, goats and sheep. It is probable that, but for the care now taken of the forests of France, whether communal or State, they would have dwindled even more than they have done, owing to the pasturing of these animals. In the Middle Ages smelting, ship-building and house-building caused great depletion of forest in France, and, as a result, the Pyrenean forests and those of the Central Massif are to-day very meagre.

Sixteen departments had one-third or more of their total area under woodland. The department of Var in Provence and the departments of Garonne and Landes are the most densely wooded

areas of France. Here over 45 per cent of the total surface is under forest. Much of the forest of Var is composed of chestnut woods, but the cork oak plays an important part, providing employment for about 3,000 workmen in the making of corks. Cork scraps are sent to England and America to be used in making linoleum. There are also considerable growths of pine, which furnish constructional timber and turpentine, and of holm oak. In the Landes the maritime pine is almost the sole species. Its chief value, apart from the reclamation of the dunes, is for pit-props, constructional timber, and resin extraction. The Alps, Vosges and Morvan come next in forest acreage, with the departments of Gard and Dordogne. The coniferous trees of the northern Alpine region are used for constructional purposes and for wood-pulping, as also are those of the Vosges and Jura, particularly the latter. In the departments of Oise and Seine-et-Oise the arid chalk uplands are being successfully planted with Scotch and Austrian pine, the timber from which is used for pit-props and telegraph poles. There is no lack of hydraulic power in these regions to turn saw-mills and pulping-mills.

In the southern Alps, as in the department of Gard in the Cévennes and in the Maures and Esterel, the chestnut tree provides an important article of diet. In Gard the wood is used by the turners for making tool handles of all sorts. Chestnut bark is used for obtaining tanning extracts.

In the northern Alps the beeches of the lower slopes are used for furniture-making. The mixed forests of the Morvan provide chiefly pit-props and constructional timber.

The forests of the Vosges are some of the most important in France. Here, as in the Argonne and Barrois uplands, the forests were terribly mutilated during the war of 1914-18, wherever they formed the scenes of battles. But a large number of industries still depend upon these forests—tanning, sawing, cooperage, charcoal-burning, paper-making, the manufacture of furniture and toys, walking-sticks, sabots, etc.

The deciduous forests of the lower lands of France are still important. They occupy the patches of Tertiary sands or clay-with-flints¹ that lie upon the limestone *plaines* of the Paris basin or the Triassic Clays in Lorraine and the wet clays of the Gault. Composed of oak, ash, hemlock and beech, they grow in coppice formations for the most part and are used mainly for firewood, for wood is still the chief household fuel for the agricultural parts of France. Oak bark, like chestnut, is still of value for tanning, but imported quebracho is superseding both these products.

The sweet chestnut is very common on the crystalline rocks,

¹ The great forest of Mormal is situated on clay-with-flints.

where it sometimes forms dense growths, as on the slopes of the *Monts du Lyonnais*. It requires a great deal of moisture, so that we do not find it on slopes close to the Mediterranean, but it forms thick woods on the northern and high slopes of the *Maures*. It provides an important article of food in *Provence* and *Aquitaine*, but the production has fallen off of late owing to disease attacking the trees and to forest fires.¹ The walnut was common in the *Rhône* valley and on the edges of the valleys of the *Causses*. The fruit is apt to be damaged by early frosts, so it does better in the milder west. It is disappearing even more rapidly than the chestnut, making way for the vine and orchard trees, because of the competition that walnut oil has met with from imported vegetable oils.

Poplar and willow are ubiquitous in France. They grow on the flood-plains of the rivers and can be seen wherever the land needs draining. The rapidly growing poplar is a great boon to the poor peasant and gives character to the lowlands of the *Midi* and to the wet plains of *Flanders*.

Fruit Trees. The almond is a typical culture on the drier soils of the *Midi*, especially in the southern valleys, where frost is not feared. It generally occupies the poorer soils of the porous terrace gravels. *Aix-en-Provence* is the chief market for almonds in France.² A large number of people are employed in grading and packing for export.

The culture of the olive is also strictly limited by climatic conditions. The cultivation of this tree has suffered of late years, both from disease and from the increasing use of oil from imported seeds which are employed to dilute the pure olive oil. The growing utilization of butter and margarine in the south instead of oil is probably another factor in the decrease in olive cultivation and one that will increase in importance. Still France produces large quantities of oil from trees that are carefully cultivated and exports up to 8,000 tons per annum. *Salon* is the chief market, but *Aix* and *Avignon* also prepare and market the oil. *Marseilles* is the port of export. In all these centres there are soap and chemical works, based on olive cultivation.

In 1937 about 330,000 acres were under fruit trees. The cultivation of fruit trees is becoming more important. In the north-west the small cider apple tree is ubiquitous. Cherries for bottling and preserving in sugar are produced in very large quantities in the *Rhône* basin, in the *Côtes de Lorraine*, and on many sunny, limy slopes. The production of dessert fruit, *William* pears, peaches and apricots is an industry confined to the south

¹ The production fell from about 450,000 tons in 1900 to 100,000 tons in 1929, but increased slightly to 125,000 tons in 1938.

² See also p. 301.

and to the neighbourhood of the main railways. It has severe competition from America, but production has made progress in quality and quantity in spite of the difficulties placed in the way by a capricious climate with sudden falls of temperature and drying winds. Aspect and protection from frost is everything in fruit cultivation, so we find in the south the hardier northern fruits, apples and pears, growing on the northern slopes and the more delicate peaches on the protected southern slopes. Open hillsides with plenty of air and light are best for fruit. Narrow valley bottoms are avoided because of the liability to frost in winter. Apricots are hardier than peaches, and with them the cultivator can take advantage of the alluvium of the valley bottoms, and a plentiful supply of water to the roots. Cherries, being very perishable, are not cultivated far from the railway.

PASTURE AND LIVESTOCK

Natural pastures are of three types: the first is mountain or summer pasture. This occurs in the uplands, below the line of perpetual snow, and particularly on the shoulders of the limestone mountains between the steep-sided, wooded valleys. These are the *alpages* to which sheep and cattle are conveyed during the summer months. They usually have a short, sweet herbage which is peculiarly nourishing. The sandstone uplands do not produce so rich a pasture, peat and heather, with a coarse, sparse herbage intermingled, being the rule. The high summits of the Vosges and Cévennes with their acid soils, also provide but poor pasturage. On the lower slopes, however, as in the plateau of Millevaches, where the rainfall is heavy, grass grows plentifully, and there is fairly good cattle pasture. The rich soils of the volcanic rocks often produce good grazing at a great elevation, e.g. the Cantal district. On the high limestone plateaux of the Causses water is so scarce that only scant sheep pasture is available. The same conditions limit the use of our bare chalk downs.

(The second type is the lowland *bocage* type, occurring in districts with an even distribution of rainfall throughout the year and a humid atmosphere. Here the temperature conditions make it possible to leave the cattle out of doors for a great part of the year. The growth of grass is somewhat rank on the better soils under these climatic conditions, and the pasture is therefore more suited to cattle than to sheep. Where the soils are naturally poor and where communications have not been good enough to make improvement, by the use of fertilizer, possible, we find a poor semi-moorland pasture, only capable of feeding small numbers of sheep and cattle. Salt marshes offer a third type of

grazing, specially adapted for sheep, but on which cattle are sometimes grazed too. Cattle- and sheep-rearing is not confined to the natural pastures. There is a growing tendency to combine cattle, sheep and pig-rearing with agricultural farming.

(SHEEP. France has between nine and ten million sheep. The areas having the densest distribution of sheep are the region

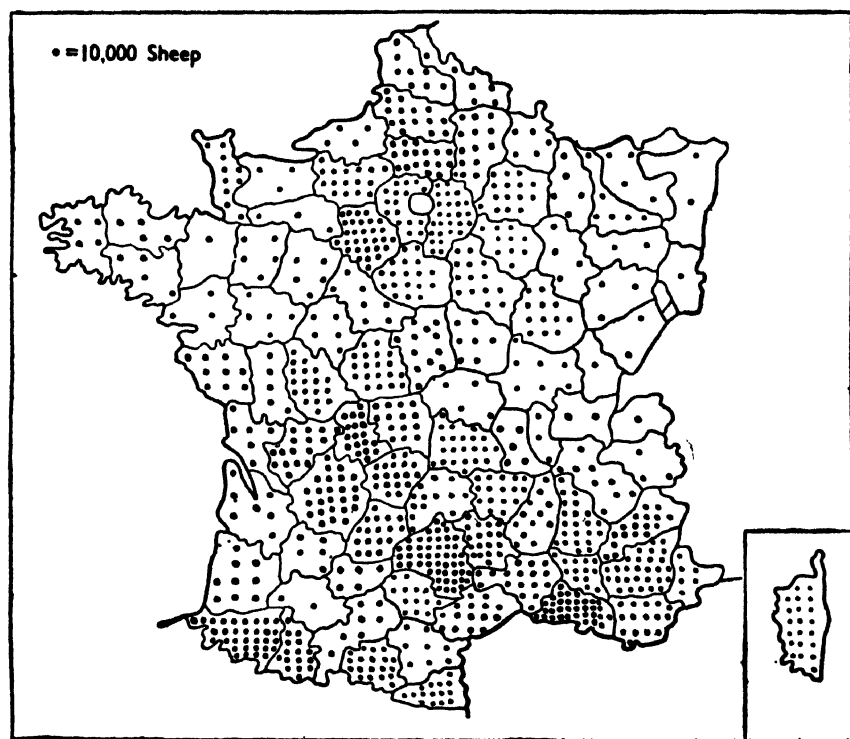


FIG. 70. DISTRIBUTION OF SHEEP BY DEPARTMENTS, 1937.¹

around and to the north of Paris, the departments centring on and including Haute-Vienne, the region of the southern Causses, especially Aveyron, the Bouches-du-Rhône, and the lower Rhône basin and the eastern and western Pyrenees.

(Of the lowland natural sheep-grazing areas, the Landes and the Cotentin are the only regions showing any density. In the Cotentin, where three-quarters of the land is permanent pasture, cattle and horses predominate. Throughout the *bocage* lands there are but few sheep, and those of a poor type, for lime and

¹This and the following eight maps are based on figures taken from *Statistique agricole annuelle*, 1939.

phosphates are lacking in the slaty soils of the Armorican Massif. They graze generally on the rough land or in the hedgerows. Their wool is used by the peasant's wife in the household, and lambs are bred for meat. On the *bocage* lands of La Manche sheep are reared which are said to have originated in flocks from the Stour valley in Kent, accustomed to damp conditions. This breed is also reared on the salt marshes of the coast, especially in the bay of Mont St. Michel, and in the marshy meadows of the interior. In the drained marshes of Deux-Sèvres, Charente, and Charente-Inférieure also, sheep do well. The Sologne pastures are of the heath type, and, like the rough lands of inland Brittany, afford but poor grazing.

Large numbers of sheep are grazed on the uplands of the Central Massif, although the conditions are by no means always very suitable. In Aveyron, in spite of the large number of sheep reared, it is too rainy and the grass is too rank for the conditions to be considered satisfactory. In Marche and in the higher Limousin plateaux sheep-rearing has a certain importance, but the department of Creuse has poor soils and the sheep are sent down to the plains or to the valleys of Morvan and Charolais to be fattened. (In the plateau of Bas Limousin conditions are better and the quality of mutton improves. Sheep are not reared for wool much here, though, for the climatic conditions are too moist.) In Morvan interest is concentrating on cattle rather than on sheep. This is due to pasture taking the place of the better ploughlands. In the rich valleys of Lauragais, in the departments of Aude and Tarn, in spite of high winds and a great range of temperature, sheep do well because there is good winter fodder after the harvest. In this area sheep's milk is generally sold as such, but in Aveyron and in the Causses generally sheep's milk is used for cheese-making, because transport of milk is not possible. There are over 500 Roquefort cheese factories. Owing to the extreme temperatures sheep on the Causses have to be folded all the year round. Small patches of beet, artichokes and maize are cultivated for lambs in the fold; but lambs are generally sold when a day or two old, their skins being used for glove making at Millau, for there is difficulty in providing fodder in the winter.

(The merino sheep and merino cross-breeds are found throughout France, but the most Spanish type of French merinos are naturally those of the Mediterranean lands, where conditions of soil and climate more closely resemble those of Spain. This animal is reared chiefly for its wool.) It was introduced from Spain by Louis XVI, when a flock of selected sheep from Leon was brought to the experimental farm at Rambouillet.¹ Other

¹ P. Diffloth: *Races Ovines*, p. 292.

flocks were imported at intervals, and great efforts were made to establish the merino in other parts of France, but without permanent success. The Rambouillet sheep farm, however, after various vicissitudes, remains a most important centre for the distribution of the merino stock, now modified by selection. The animal is long-limbed, adapted for walking long distances, has a long neck and pleated skin, which increases the wool-bearing surface, and the wool is fine, white and wavy. There are many local varieties.

In Crau and Camargue the great heat of summer makes *transhumance* a necessity. In this region sheep-farming is extensive. Only one sheep can be grazed to the acre in Crau. Hay, grown under irrigation, supplies deficiencies to some extent. In Camargue four sheep can be fed to the acre on the marshes, after the winter floods, but the feed is rather meagre during the winter and mortality is high. Lambs are therefore sold early to the butcher.

The scorching of the herbage and the difficulties of watering the flocks in June originated the custom of sending the animals to the mountains for the summer. Movement begins in May to the foot-hills, but for the high Alps, where the snow lies long, it has to be delayed till June. Much of the migration is accomplished to-day by rail, to centres such as Grenoble, Montmélian, Gap and Digne, whence the flocks proceed on foot, grazing by the way, to the high pastures of Dauphiné and Savoie. In Drôme, Hautes-Alpes, and Basses-Alpes considerable numbers of sheep are reared all the year round, a local transhumance being practised, but the mountains of Savoie, Haute-Savoie, Isère, Alpes-Maritimes, and Var only receive sheep in summer, and then only on those pastures which inaccessibility and lack of water make impossible for cattle pasture. The return to winter quarters in valleys and plains takes place in November, and on foot. The flocks number generally from 800 to 1,300 head.¹

There is great division of labour in the sheep-rearing industry of these mountain regions. The lowland farmers feed the sheep during the winter months, employing hired shepherds from the Alps. They employ gangs of shearers, who go from farm to farm. For transhumance they are placed under the care of another set of hired shepherds, who take them to the mountains, and hire pastures for them from the farmers of the valleys *en route* if necessary. Sometimes the sheep are distributed among local farmers, who thus get their fields fertilized, while the commune receives a fee. In the south-west Central Massif, and the western and eastern Pyrenees also, the sheep 'live in a perpetual

¹ Improvement in the cultivation of irrigated fodder crops has made possible in some areas a discontinuance of the custom of transhumance, which has the disadvantage of encouraging the spread of disease.

state of transhumance', leaving the valleys in July for the high mountains, where they feed on the short grass of the combes, and returning to the valleys in September. They travel long distances over the plains of Garonne and Dordogne, according to the amount of artificial forage to be found in the valleys. In the mountain they are milked every evening by the shepherd who hires them and who is paid by the cheese he is able to make. Most cheese is made in the winter, when the richer food provides better and more milk.

There is an increasing tendency to rear and fatten sheep on the agricultural land. This habit is especially prevalent in the *plaines*, or low limestone plateaux of the Paris basin, and the north. In the departments of Eure, Manche, and Seine-Inférieure in Pas-de-Calais and Somme, the hardy, thick-fleeced Boulonnais type (the Ditchly merino) and merinos are reared, chiefly for the Paris market. They live out of doors from April to November. Artificial forage plants—trefoils, colza and turnip—are fed to them in the winter, and in the north they get beet pulp as well. They graze over the stubble after harvest and help to fertilize the ploughlands. In Champagne, Burgundy, Brie, and Orléanais the merino sheep is found, but not in the lower, moister districts. In the plains of Berry a hardy type of sheep is reared, which predominates also in the Morvan, Jura and Ardennes. Its meat is said to resemble Welsh mutton. This sheep has a fine wool, on which, in earlier days, was based the fine cloth industry of Châteauroux. This type of sheep has been crossed with English races and now the meat-producing qualities are more important than the wool. In the plains of Poitou the rearing of sheep increased as a result of the phylloxera plague, when much of the vineland was put under fodder crops. The meat is not good, but has the advantage of going 'on the hoof' to the markets of Paris.

CATTLE. Cattle are reared everywhere in France, except in the semi-arid Mediterranean lands where not only pasture but watering is a difficulty. Even so, in the marshy lands of the Rhône delta cattle manage to find a living, the department of Bouches-du-Rhône having nearly 15,000 head. A comparison of Figs. 70 and 71, showing distribution of sheep and cattle respectively, will bring out the fact that whereas the sheep appear to avoid the districts where marine influence is strong, and still more those where rainfall is heavy and the subsoil impermeable, it is precisely on the Hercynian Massifs of impermeable archæan rocks, especially where the rainfall is heavy, that the largest number of cattle are found. Cattle require much longer and

¹ With the exception of the salt marshes.

coarser herbage than sheep, partly on account of the different formation of their mouths and jaws and their consequently different methods of cropping; moreover, they are less well adapted than sheep to movement over rugged and steep slopes; they are naturally creatures of the plains.) Nevertheless we find cattle distributed all over France except in the departments

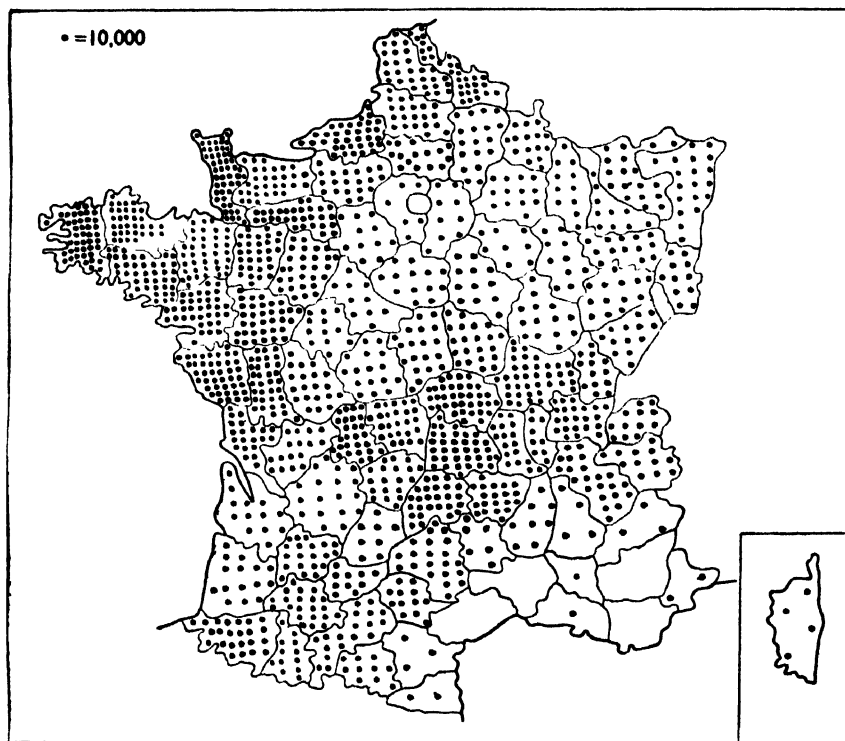


FIG. 71. DISTRIBUTION OF CATTLE BY DEPARTMENTS, 1937

bordering the Mediterranean, where they are limited to the marsh pastures of Camargue or the valleys of the Alps and Pyrenees. In the Midi the sheep and goats are more adapted to the climatic conditions than cattle; even pigs do better.

It must be remembered that, until the last fifty years or so, cattle were reared and owned in small numbers and all had to perform many functions. (There was little specializing. Oxen were used for ploughing and draught purposes and were later sent to the butcher; cows too had to do their share of labour on the farm in addition to producing the calves (converted at an early age into veal), and milk for the use of the farm. Certain

breeds had been gradually developed which were, to a great extent, adapted to the conditions of soil and climate in which they had to live.

The characteristics of cattle-rearing in the more important dairy and meat-producing areas will be briefly reviewed.

(The five districts in which there are most cattle are the Armorican Massif, the Central Massif, the Saône basin, the Pyrenees, and the northern district of Picardy, Artois and Flanders.) Within these larger areas certain departments have a dense bovine population—the four Breton departments, Manche, Seine-Inférieure, Vendée, Basses-Pyrénées and Saône-et-Loire. These correspond to some extent to the areas of greatest grassland percentage in relation to ploughland; but not in west Brittany, where there is a large proportion of ploughland and less than 25 per cent grassland, and in Caux and Vendée where there is less than 50 per cent grassland. Probably the stimulus of the Paris and British markets for Normandy and Brittany butter and meat has been responsible for the more intensive rearing of cattle in these districts.

In Brittany the cattle are in the fields or on the commons (*landes*), except in the worst winter weather. In the interior and in the poorer south the small black and white animals are hardy and extremely good milkers. The oxen are used for the plough. Quimper exports to London. In the '*ceinture dorée*', particularly in Finisterre, where the pastures are better fertilized, the cattle are of a heavier type and the race is much mixed by crossing with English breeds, which makes for better adaptability for fattening. This is done particularly where, on the better fertilized soils, horses do the ploughing.

In the highlands the main problem in cattle-rearing is the supply of winter fodder. The cultivable area in the valleys is so limited that it is not possible to provide crops other than grass and lucerne and other plants of the clover type, and to provide sufficient dry food it is necessary to cut the grass or clover a number of times. Hence the importance of irrigation in the upland valleys. Lack of winter fodder means selling the calves at an early age to the butcher.

In Limousin, Périgord and Angoumois the yellowish-fawn (*froment*) cattle of the Limousin race predominate. On the lower plateaux, where relatively good communication facilities make liming and the use of superphosphates common, root crops are possible and the cattle are reared mainly for meat. During five months of the summer half-year they live on the permanent grazing lands, and the rest of the year they are stall-fed. Naturally the type improves in the richer meadows near the centre of

the Limoges basin. The animals employed to work on the farms are fattened for the market at about five years; calves and young heifers are sent direct to the butcher, or fattened in the neighbourhood of Limoges on roots, etc., or sent to the lowlands for further fattening. On the higher plateaux, dairy cattle for cheese-making are reared.

In Auvergne, in the Cantal department, the soils of the volcanic plateaux of Cézalier and the little Planèze, provide excellent pasture at an elevation of between three and four thousand feet above sea-level. Here the famous *Salers* race is reared. This race is found also in the neighbouring departments, especially to the north-east and south-west. (The characteristic deep, vivid red colour of these cattle appears to be confined to the volcanic areas,¹ and, generally speaking, they do better on these rich soils. The milk is used for making the large Auvergne cheese, *fournes*, but the animals are used for draught and make good meat. In the summer the cattle feed on the high plateaux, where the farmers hire grazing-ground. In the winter they come down, often fifty or sixty miles, to the low cultivated plain at 1,500 to 2,000 feet, and are fed on hay. Co-operation is not greatly practised here, so the small peasant who only has a cow or two rears them ultimately for meat. About half the calves are sold young to the butcher; the rest go down later to Limousin and other lower lands to be fattened for market. Now the cattle travel by rail to the high pastures, like the sheep from Camargue, if the distance is great. At the end of September the pigs go up to the high pastures too, so that the whey shall not be wasted.

In Charolais (Saône-et-Loire), where the granite is covered with Lias Clays and marls or *gaize*, the land is largely under natural meadow. Here the object of cattle-rearing is the provision of meat. The Ardèche basin supplies the Rhône valley towns with milk, and cattle of various breeds are brought from all the surrounding uplands to be trained for farm and draught work in the plain.

In the Vosges the *Hautes Chaîmes* supply poor summer grazing, which is, however, improving owing to the lime and phosphates supplied to the soil. There are cattle markets and fairs held in the towns on the edge of the Massif for the calves and for the young animals, eight to ten months old, that are sold to be trained as oxen. The cows remain in the upland till their time comes to be fattened for market.

(On the granite highlands of the south, red and black or red and white cattle of mixed race, known as *Ferrandaises*, are reared. These are hardier and better adapted to the poor herbage

¹ P. Diffloth: *Races Bovines*, p. 234.

than the *Salers* race. They are reared in the highlands west and east of the Rhône valley, from Aveyron to the valleys of Drôme and Isère. They are good workers and fair milkers, meat being the chief product, but cheese also is made. These cattle are very hardy, and are able to live out of doors from May to October in all weathers at 3,000 to 5,000 feet. The oxen are very powerful and can stand the summer heat well.

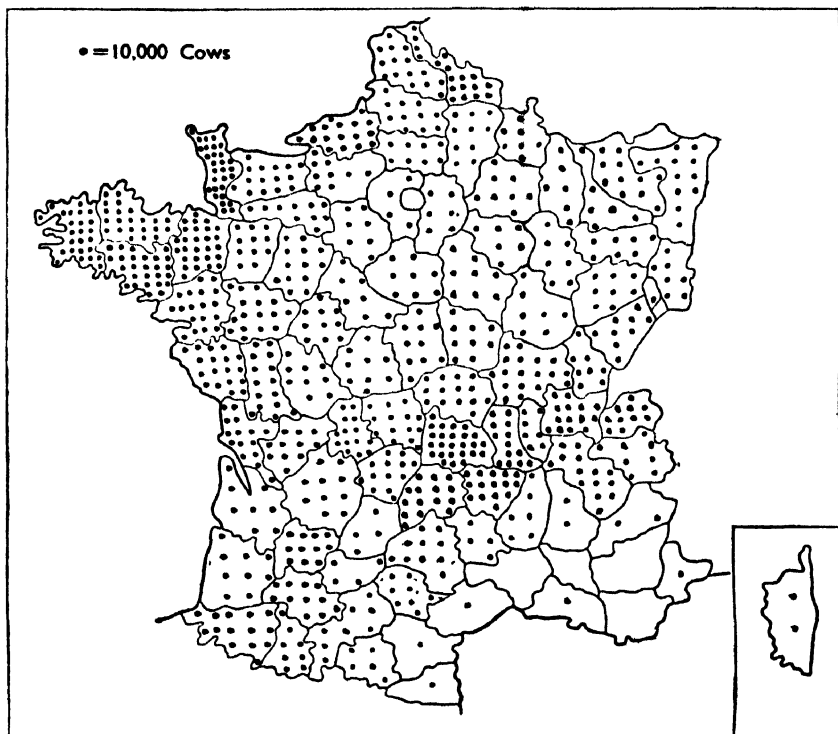


FIG. 72. DISTRIBUTION OF MILCH COWS BY DEPARTMENTS, 1937

In the Alps a race of cattle known as the *Tarentaise* predominates. These cattle are excellent milkers. *Gruyères*, *persillés* and other local cheeses are made. In Maurienne sheep and cows' milk is mixed to make the Mont Cenis cheese. The hardy Montbéliard milch cattle are sought after in the northern Alps and Switzerland. Transhumance is practised throughout the southern Alps, but there are few local cattle.

In the Pyrenees the fawn (*froment*) coloured cattle live high

in the mountains in summer. They are very hardy and as alert and agile as deer. Down in the Gascon plains the heavy grey cattle are good workers and are able to stand the heat and flies in the summer. They are chiefly stall-fed.)

It is interesting to note that, although the number of cattle and even of dairy cows is greater in the Central Massif and in the *bocage* lands than on the *plaines*, yet the major and modern dairying districts are more or less confined to the latter. The reason is, of course, that the poor granite and arenaceous impervious soils feed cattle because they will not produce crops of value, and the *limon*-covered limestone *plaines* are as good for dairy-farming and cattle-rearing as they are for cereals. These *plaines* are devoted to cereals when prices are good, but are turned over to cattle-rearing as soon as the market turns in favour of these occupations.

Cattle-rearing, for dairy and meat-producing purposes, on the agricultural plains is becoming more and more important, and in some districts, as in the upper Oise basin on the edge of the Ardennes, is becoming intensive.

In the Charente and Sèvres basins the vine-growers migrated in large numbers to the towns as a result of distress caused by the disastrous phylloxera plague, and farmers from the *Bocage* of Vendée filtered in, bringing with them their cattle. The vine lands proved capable of producing forage crops.¹ Co-operative dairy-farming was introduced about 1885, and, though there was a slight set-back during the war of 1914-18, they are now doing well. Most of the dairies lie in the centre, north of Charente-Inférieure and in the south of Deux-Sèvres and Vendée, on the limestone *plaines* and the marshland of Poitou. This development, of course, does not extend to the *bocage*.

CHIEF CROPS

We will now consider briefly the main agricultural crops, and we will ask our readers to refer to the distribution maps, Figs. 73 to 80.

WHEAT. The French of all classes eat wheaten bread. Rye and buckwheat are the bread crops of restricted areas, where acid soils and damp climate are unsuited to wheat cultivation, and even here the use of white bread is becoming more and more common.)

The paramount position of wheat as a staple crop may be due to the early association of Gaul with the civilization of the

¹ G. Reverseau : ' Industries laitières dans les Charentes ' (*A. de G.*, 1925).

Mediterranean, but it is doubtless largely also due to the suitability of soil and climate conditions to wheat cultivation. Nowhere in France do we meet with the cloudy and damp conditions that preclude the growing of wheat in the western counties of Britain. France, compared with Britain, is a relatively sunny country. Wheat is well known as a crop that can stand considerable extremes of temperature and is very adaptable as

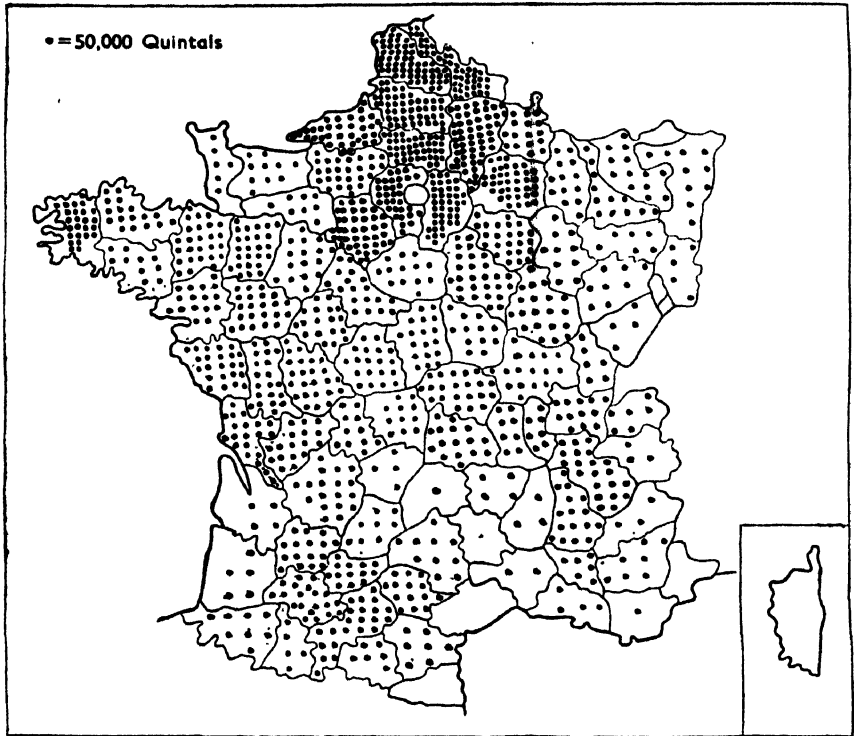


FIG. 73. WHEAT PRODUCTION BY DEPARTMENTS, 1937

regards soils and water supply.) Moreover, there is probably no country in the world where soils have been so changed by secular human effort as in France. It is obvious that, (with the great variety of soils and climatic conditions that France possesses, the types of wheat must vary greatly from district to district.) M. Faucher¹ has pointed out in his *Rhône Moyen* the agelong selection of grains to suit local conditions even in the restricted area of the Middle Rhône.

¹ D. Faucher: *Plaines et Bassins du Rhône Moyen*, p. 316.

(Wheat is so universally cultivated in France that the average yield per acre is not high, though it has improved with the ever-increasing use of artificial fertilizer.¹) The average yield for the period 1933-37, was 15·3 quintals per hectare, compared with 31·3 in Denmark, 29·6 in the Netherlands and 26·5 in Belgium.

(The distribution of the more important wheatlands coincides with that of the great limestone plateaux—the *plaines* about and particularly to the north of Paris and the plains of Picardy and Artois, the *champagnes* of Beauce, Brie and Berry—which do not rise much above 600 feet, and which, with a warm, limy, and well-drained subsoil combine fertile surface loams.²) These loams of Pleistocene age cover very large areas of the limestone high plains. Their origin has been much discussed. They appear to have much in common with the yellow *loess* deposits of central Europe, and may well be of aeolian origin, though in places they exhibit lamination which points to a redeposition under water. However that may be, they do provide soils almost universally fertile, of depths varying from three to thirty feet or more. Sometimes they are lacking in lime, but as the underlying rock is mainly limestone this deficiency can usually be remedied without great cost. The loam sometimes lies directly upon the chalk or limestone, when it is well drained, warm and dry. Such conditions are peculiarly suitable for the cultivation of wheat and sugar-beet. In the department of Somme the Marqueterre and Ponthieu districts grow much wheat, and in Santerre there is a very high yield of wheat where the loam lies directly on the chalk. The wheatlands in the devastated areas have recovered remarkably.

Where clay-with-flints or Tertiary Clays intervene, a less well-drained, colder and heavier soil results, and here we find mixed farming, the rearing of cattle, and growing of forage crops predominating, though the cultivation of cereals may be important. Where the loam in the chalk *plaines* has been washed off, exposing the clay-with-flints, the soil is so cold and heavy, and often so full of stones, that it can only be worked with great difficulty, and the return to cultivation is not high. Nevertheless wheat is one of the main crops sown on this type of soil, as it is on the heavy Liassic and Triassic Clays of Lorraine, though grazing and orchard occupy much of the land.

(Where the limestone and chalk are exposed in the *plaines* the soil is very thin and lacking in humus and dries too quickly. Here again, owing to the lavish use of fertilizer, wheat is the

¹ Fertilizers used are chemically-produced phosphates, Alsace potash, basic slag, etc., from Lorraine.

² Departments of Pas-de-Calais, Somme, Aisne, Oise, Marne, Seine-et-Oise, Seine-et-Marne.

main crop cultivated, but cultivation is extensive and the yield poor. Beet does not do well on these thin soils. Wheat is cultivated more intensively on the alluvial terraces of the Seine and Armance.) In the departments of Oise and Aisne, on the Tertiary limestones of Valois and Soissonais, the deep loam is cultivated mainly for wheat and beet. (Large farms are the rule, and up-to-date machinery is used in conjunction with steam, petrol, or electric power. Where the *calcaire grossière* is devoid of loam the soils are poor and there is much woodland, as there is also when the limestone is covered with Tertiary sands, e.g. the forest of Compiègne.

Brie Champenoise is another region of intensive wheat and beet cultivation, the production approaching in importance that of Beauce in the department of Eure-et-Loire.

(The highlands are too bleak and cloudy for wheat cultivation and too inaccessible for fertilizing, but the granite soils of the Breton coast-lands take fertilizing well and produce good crops.) In Côtes du Nord, especially where the crystalline rocks are loam-covered, wheat is intensively cultivated.¹ Maine-et-Loire, Loire-Inférieure, Vendée and Charente-Inférieure grow large quantities of wheat because fertilizer is available at low cost for the soils deficient in lime and phosphates. In the north, Ile-et-Vilaine, Calvados, Orne and Sarthe, damper and cloudier, and with good natural pastures on the Jurassic Clays, produce but little wheat. The rainy highlands of the rim of the Paris basin are of course not cultivated, but beyond them wheat cultivation begins again on the heavy clays of the plains of Lorraine which the forested Vosges separate from the wheatlands of Alsace. In Aquitaine wheat tends to give way to maize as the rainfall increases towards the western Pyrenees. In Provence and Languedoc wheat is the main cereal, but, owing to restricted agricultural lands, is not produced in large quantities.

Oats. (The distribution of oat cultivation depends largely on humidity of climate, and thus oats are grown intensively in a zone stretching from the Atlantic in the departments of Charente-Inférieure and curving northward through Paris to Pas-de-Calais and Nord.) (The northern portion of the Breton peninsula also produces large quantities.) Elsewhere, north of the latitude of Lyons, oats are grown in fair quantities. To the south, except in Toulousain, little is grown on account either of elevation or of excessive dryness of the atmosphere. Oats are chiefly important as a fodder crop, both in the dairy regions and where cattle are reared for meat.

Rye is grown on the poorer lands of the northern Central

¹ See p. 87.

Massif with wheat and oats, but extends farther south than these other two cereals into the farming lands of the highlands in Corrèze, Cantal, Lozère, Haute-Loire and Loire. Considerable quantities are also grown in Morbihan on the less fertile granite soils, and again on the thin chalky soils of *La Champagne pouilleuse* in the department of Marne. In Moselle rye straw is used for hat-making.

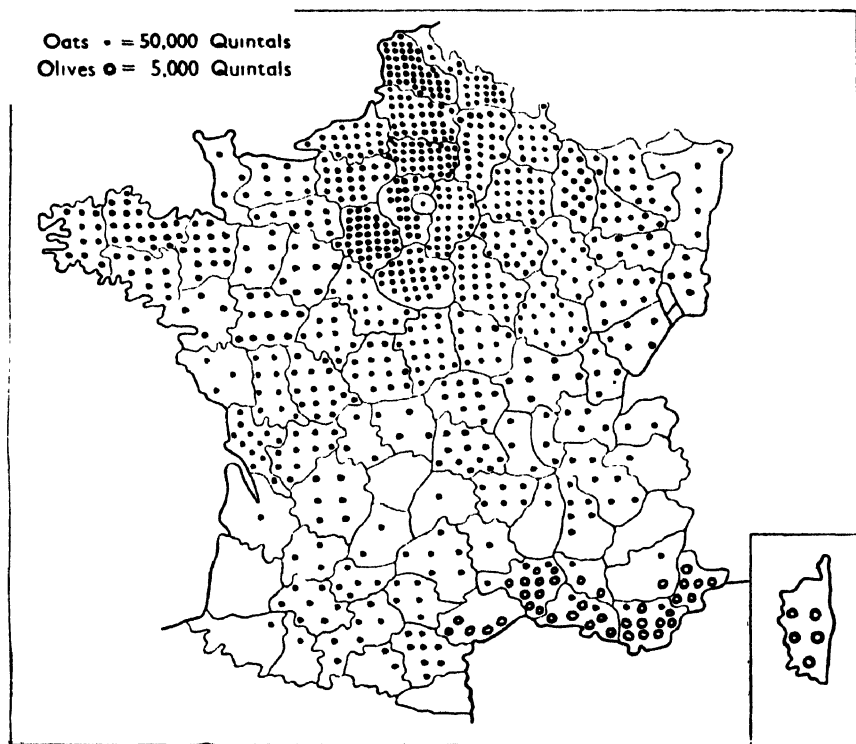


FIG. 74. PRODUCTION OF OATS AND OLIVES BY DEPARTMENTS, 1937

Barley is not an important crop in France, except in one or two areas, e.g. Ile de France, Cotentin peninsula, Maine and Berry, Alsace and Lorraine *Annexée*, where it goes mainly to the breweries.

Buckwheat, like rye, is the crop of poor soils. It is cultivated almost exclusively in the west and north-west of the Armorican *bocage*, where it provides the breadstuff for the peasant population. It shares this function with rye in the department of

Corrèze in the Central Massif, and it is also cultivated in the ungrateful Dombes lowlands in the department of Ain.

Maize is an important crop only in the south-west, where the early summer rains and great warmth with freedom from frost give conditions suitable to its growth in the departments of Landes and Basses-Pyrénées. The plant is grown as a fodder

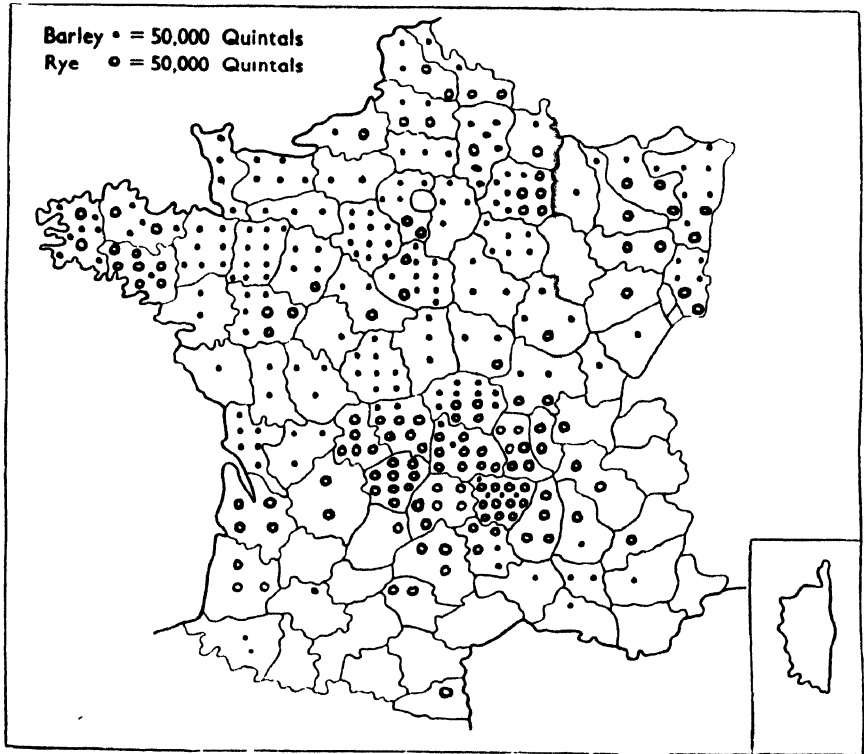


FIG. 75. PRODUCTION OF BARLEY AND RYE, 1937

crop throughout the Garonne basin. It is exacting in labour, and the acreage has therefore decreased since 1918.

The cultivation of *fodder crops*, lucerne, and clover and vetches of various kinds has been greatly increased of late years, lucerne being specially adapted to the dry *plaines*, owing to its deep rooting and free nitrogen absorbing capacities. Root crops have an increased production, particularly potatoes, which are used (part from human food) increasingly as fodder for pigs and cattle, and for the distillation of alcohol. They figure in an

important position also among the *primeurs* cultivated for the Paris and London markets. Forage beets are grown in greatly increased quantities; their cultivation is associated with the *grande culture* of the high plains.

The growing of *sugar-beet* is important in France, as the consumption of sugar is increasing with the general rise in the standard of living since 1918. The area of intensive cultivation

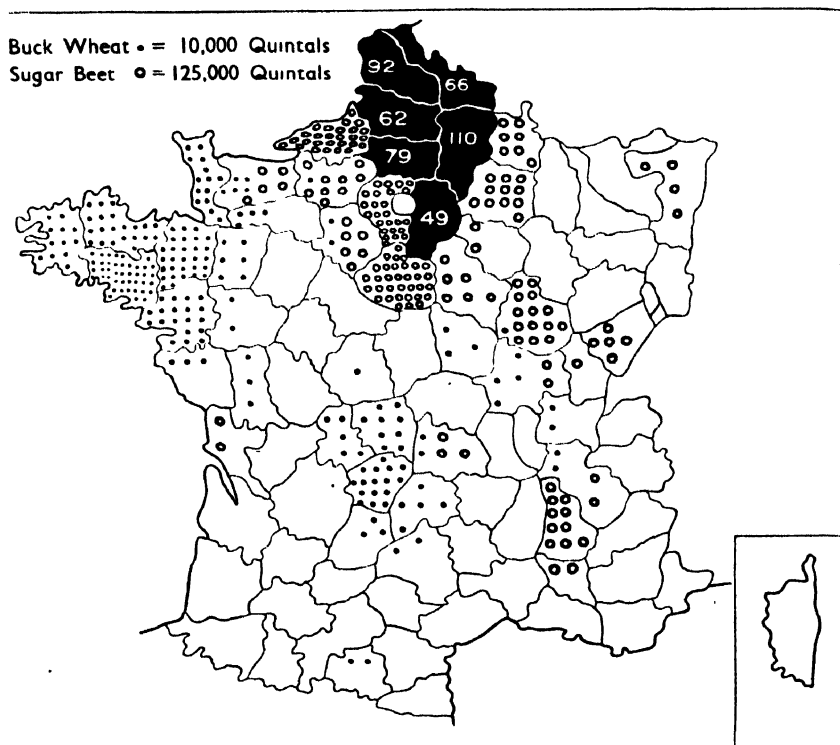


FIG. 76. PRODUCTION OF BUCKWHEAT AND SUGAR-BEET, 1937

corresponds to the area of intensive cultivation of wheat, i.e. the departments of Nord, Pas-de-Calais, Somme, Oise, Seine-et-Oise, Seine-et-Marne, and Aisne. There is a more direct relation between the two crops than the affinity of both for the same type of land: the wheat benefits directly from being grown in rotation with sugar-beet, because the intensive cultivation required by the latter leaves the ground in excellent tilth for the wheat. Small quantities are grown also in the lower Seine

basin, in the upper Marne and Aisne valleys, in the Saône plain, and the plain of the Rhine.)

The crop is an exacting one, requiring much hard labour and a great deal of fertilizer. The beet can only be grown to advantage in the proximity of a sugar refinery, and these need much coal. This fact localizes the cultivation of the crop. There were in 1913 168 sugar factories in five of the ten 'occupied' departments; in 1923-24, only 55 of these were working. Out of 213 which existed before 1914, 145 were damaged or completely destroyed. In 1938 there were only 111, but 50 of these are large modern factories, and the total capacity is greatly increased.¹ In 1925 the sugar-beet production in the 10 departments was still 36.3 per cent below normal, but by 1927 the pre-1914 production figure of between five and six million metric tons had been reached and by 1930 a peak production of 10.8 million tons was obtained. Production declined again to just under 8 million tons in 1938.

Large-scale cultivation of sugar-beet is confined to the *limon*-covered chalk plateaux—the *plaines* drained by the upper streams of the Somme and Oise, in Soissonnais and Picardy and in the chalk terrace of the Pèvele on the rim of the Flanders plain, stretching to the Belgian frontier beyond Valenciennes. It does not do well on stony soil, hence we do not find it in the regions of clay-with-flints of the higher land north and south of Amiens.

The cultivation of this crop works in very well with fat cattle-rearing, for the beasts can be stall-fed on the pulp waste during winter and early spring.

MARKET GARDENING AND THE CULTIVATION OF PRIMEURS

The large-scale cultivation of fruit, flowers and vegetables for central markets and for export is a modern development made possible by irrigation and by the invention and provision of rapid transport facilities.

Apart from the ordinary production of fruit and vegetables,

¹ Sugar factories in operation :	1912-13	1920-23	1928	1938
Nord	40	13	13	13
Pas-de-Calais	24	8	12	12
Somme	33	7	9	14
Oise	20	16	18	18
Aisne	51	11	13	13

¹ Cahill : *France*. (Department of Overseas Trade, 1928), and *Annuaire Statistique* (1939).

which varies normally according to soil and climate, there is the cultivation of early fruits and vegetables and flowers (*primeurs*), in regions that are specially favoured climatically, for the markets of the north. Both types of production are now carried on intensively owing to an increasing demand for what not long ago were considered luxuries.¹

Regions of mild, maritime climate, such as the sheltered bays of Brittany, are well adapted for the cultivation of certain *primeurs* of a hardier type, but the sunny Mediterranean regions offer opportunities for a far greater cultivation and over a much longer period of the year.

Growing for seed production may be included in the list of intensive cultivations. Here the south again offers the right conditions of long, dry summers, to ensure maturity and freedom from mildew. For the ripening of fruit and the production of blooms freedom from spring frosts and an abundance of sunshine are essential. An adequate supply of water has to be ensured by natural or artificial means. In Provence, provided there is protection from the *mistral*, and that water is available, all kinds of delicacies in the way of fruits, vegetables and salads can be grown, but not with ease, if quantity and quality are to be ensured. The work is very arduous, for the most constant attention is required, in lavish manuring, watering, sheltering from the *mistral*, and so on.

M. Faucher has shown¹ how the cultivation of *primeurs* in the lower Rhône basin was introduced in the latter half of the nineteenth century, along with an extension of wheat- and forage-growing. It was the result partly of a period in which a series of disasters had overtaken the specialized agriculture of the district (the cultivation of madder for dyes, teasles for raising the pile of cloth, and the rearing of silkworms). This is one more example of the courage and adaptability of the French cultivator. Similarly, in the dry, east-facing valleys of Tet and Tech (in Roussillon), irrigated *huertas* produce early fruit and vegetables for the distributing markets of Perpignan and Prades.

In the northern half of France the coasts of the sheltered bays of the Breton peninsula, in a mild maritime climate where spring comes early, have long been used for the cultivation of early vegetables such as potatoes, onions and tomatoes.) The flood-plains of certain rivers have been used for market gardening for many years past, in the Somme valley, round Amiens, for instance, and since 1918 near Nantes. Here the industry has outgrown the market for which it originally catered, and surplus fruit and vegetables are sent to the Norman and Breton

¹ D. Faucher : *Plaines et Bassins du Rhône Moyen*, p. 527.

ports for shipment to Great Britain, or are dispatched to Spain and North Africa. M. Musset¹ has pointed out the marked effect that the proximity of an industrial centre exerts on market gardening. Scarcity of labour enforces all kinds of mechanical devices, especially the utilization of glasshouses.

In most instances the cultivation originated in the demand of some large industrial centre, such as Lyons, Nantes, Paris. In the neighbourhood of Paris, Argenteuil (fourteen miles south-west) grows carrots, parsley and roses. Mechanization followed, owing to increasing scarcity of labour; this in turn led to increased production and a surplus for export farther afield. In this distribution, to a distance, the railways and Channel boats play a very important part.² With a development of branch railways and lately of motor transport the radius of intensive cultivation for the large centres has greatly increased. Witness the development in the Arles and Avignon district and in Vaucluse. So lucrative has the *primeurs* industry become that over large areas the vine has been 'grubbed' and the land turned over to intensive cultivation. Specialization is a natural development from intensive cultivation, so we find certain Breton communes specializing in cauliflowers, certain villages of the Lyons terraces specializing in strawberries or peaches.³ Roses are cultivated in Brie and Provins, the stocks being imported from Champagne and Burgundy. Near the towns the demand for milk competes with the demand for fresh fruits and vegetables in the apportionment of the soil.

Of the markets for *primeurs* Paris comes first, England second, and the industrial north third. Apart from the open markets of Les Halles, Covent Garden, etc., much produce is sent to canning centres like that of Metz. Peas, beans, asparagus and so forth are canned and bottled in large quantities.

A very old-established industry, that of perfume-making, depends on the specialized cultivation of flowers. It is carried on in the Maritime Alps, on the *Côte d'Azur*. All kinds of strongly scented flowers are grown—roses, orange blossom, carnations, mimosa, violets and others. Also every kind of scented shrub—rosemary, thyme, mint, lavender and a number of others.) Grasse is the chief centre and employs something like 3,000 persons in this industry, and more than 15,000,000 pounds of flowers are gathered each year in the neighbourhood of this town.⁴

¹ R. Musset: 'Les cultures maraîchères aux environs de Nantes' (*A. de G.*, 1927).

² The P.L.M. set up an agricultural service after the 1914-18 War to study questions of variety, grading, packing, marketing, etc.

³ A. Cholley: 'Cultures et commerce des Fruits dans la banlieue Lyonnaise' (*A. de G.*, 1928, p. 355).

⁴ A. Meglé: *La Côte d'Azur*.

The orange blossom is the basis for all the manufacture of Eau-de-Cologne.

In the same sheltered region the cultivation of flowers for export to Paris, London and Germany has reached great dimensions (these fragile articles of export are entirely dependent on efficient transport). Nice and St. Laurent-de-Var specialize in carnations and wallflowers, Antibes in roses, Cannes in mimosa,

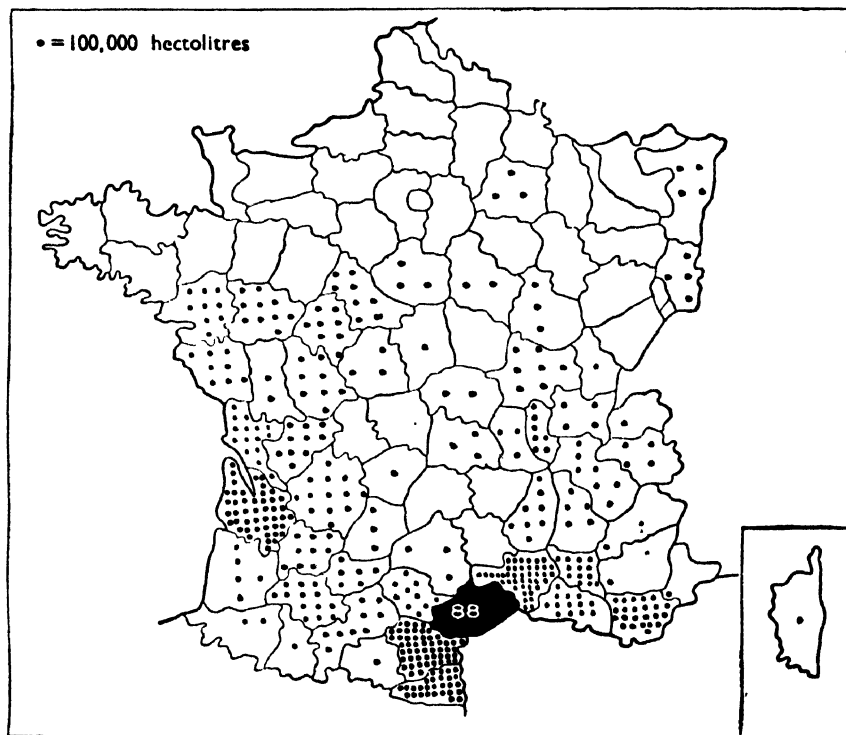


FIG. 77. PRODUCTION OF WINE BY DEPARTMENTS, 1937

Hyères in violets, the Toulon district in narcissus and other bulbs. The cultivation of 'cut flowers' is continued in the west. Toulouse makes a special cult of Parma violets.

VINEYARDS. France is the most important wine-making country in the world, and produces more types of wine than any other land; for, although Italy has a greater total area under vineyards, French average production per hectare is about double that of Italy, while France has a virtual monopoly of fine wines. (She is peculiarly favoured in regions suitable for vine cultivation.

In the north-west, it is true, there is too much humidity and too little sunshine for vines, and we find that apple-growing for cider takes the place of the vine, and in Flanders the local drink is beer. Again the bleak uplands in the centre and west are obviously inimical to vine cultivation. The west Pyrenean foothills and the southern Landes are likewise unsuitable, owing to the warm, moist air which encourages mildew. As soon, however,

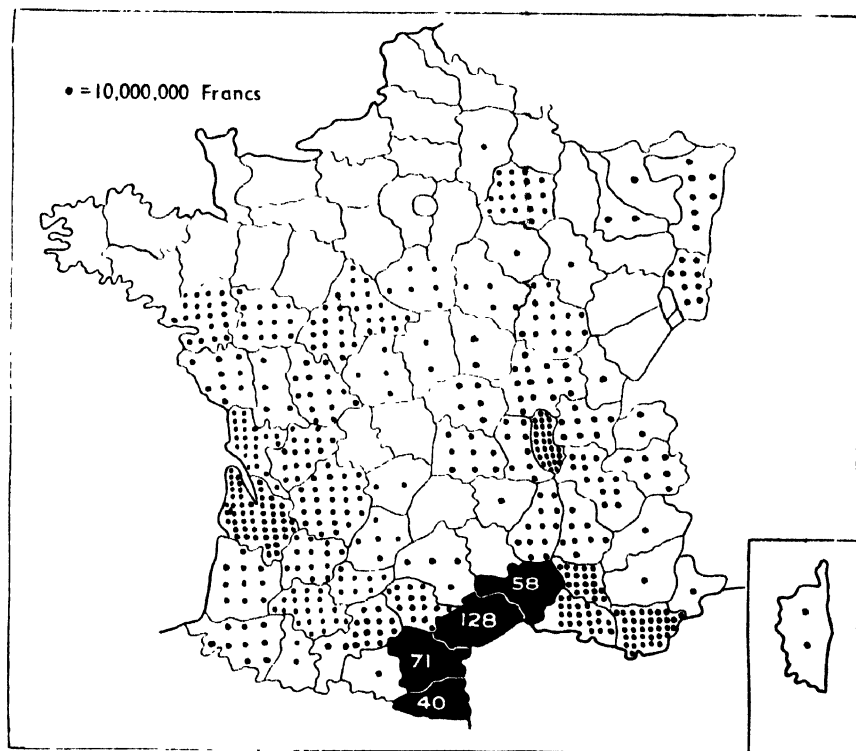


FIG. 78. VALUE OF WINE PRODUCED BY DEPARTMENTS, 1937
(Based on figures in *Statistique agricole annuelle*, 1937)
Dots indicate production for 1927. Figures indicate production for 1937.

as we reach the characteristic Paris basin climate and the warm eastern rim of the basin of Aquitaine, we find the vine cultivated wherever the limestones offer sunny slopes.)

(The essential conditions for the commercial cultivation of the vine are strong and continuous sunshine during the late summer and early autumn and a moderate rainfall.) The plant can withstand a considerable degree of frost; its deep roots can find moisture during a prolonged dry period. It is not particular as to the type of subsoil, but it prefers a loose stony or gravelly

soil to a compact clay, for it does not do well in humid conditions. The predilection of the vine for the drier, stonier unirrigable soils has had one great advantage for the vine-grower, for French land taxation is based on a valuation of land from the point of view of grain cultivation.)

In the north and centre, where climatic conditions are characteristically variable, the cultivation of the vine is something of a speculation; nevertheless it is near to the northern limit that some of the best vintages are grown, a fact which may in part be due to the exceptional care necessitated by the climatic conditions.) If Figs. 77 and 78 are compared it will be seen that certain departments, where the quantity of wine produced was relatively small, yet stand high in regard to the value of the wine produced. The most notable examples are those of the departments of Marne and Côte d'Or. The department that produces the largest quantity of wine is Hérault, and all the departments of Bas Languedoc produce heavily, because, with the loose soils and limy subsoils and the long, sunny autumns, conditions of soil and climate on the Mediterranean terraces are ideal for the vine.

In the eastern Pyrenees it has attained to a great development. In the west the heavy rainfall encourages fungoid pests such as mildew, and both quantity and quality diminish. It becomes a precarious crop, needing much attention, which it by no means always repays. Away from the cloudless Mediterranean skies the vines need help to procure the greatest amount of sunshine for the fruit.) In Provence, Bas Languedoc and Roussillon the vine is grown in close rows, and the grapes are more or less hidden beneath the foliage. In Ariège and Basse-Pyrénées the vines trail over high, horizontal supports to ensure to them a maximum amount of insolation. (Towards the north only the sunniest slopes and warmest soils can be profitably cultivated for vine. Here aspect is all important.) The cultivators frequently pick off a portion of the leaves in order to allow the sun's rays to reach the fruit, and the plants have to be well spaced and are kept very short.

In the plain of Roussillon and Languedoc large areas are given up to the '*petits vins*', which supply a large proportion of the *vin ordinaire* of the country. This cultivation *en gros* means that less care can be devoted to the plants and that there is a greater danger from disease. It also means that the peasant is obliged to cut out other crops to find space for the vine on the plains, and to incur the risks attendant on placing 'too many eggs in one basket'. The olive and the fruit tree have had to give place in Languedoc to large-scale vine cultivation. After

the phylloxera plague of the middle of the nineteenth century, the country was replanted largely with American stocks, immune to the phylloxera blight, which also came from the United States. These new vineyards have been so extremely productive that the farmers have been tempted to subordinate all other farming to viticulture. This is a dangerous proceeding which puts the *vigneron* in the same position as the hop-grower. In a good year the price drops too far, and in a year of scarcity only the growers of good wines can reap a profit.

The wine of the Midi is the *vin ordinaire* of popular consumption. The alcoholic content is high, particularly for the liqueur wine, for which special vines, such as muscat and granada, among other species, are used. In Provence cultivation is more varied, and the vine has to share the available land with the olive and fruit trees and the *primeurs*. In Aquitaine are produced the famous liqueurs of Cognac and Armagnac. Cognac is made from wine produced on the light soils of the Charente. Armagnac, which has a less important market than Cognac, perhaps because it is farther removed from important lines of communication, is produced from the vineyards of Gers and Landes on clay soils.

The other wine areas that are world-famous as producing vintages of peculiar quality are Bordeaux, Burgundy, Champagne and the Rhine. Bordeaux wine is grown throughout the Garonne basin in Aquitaine, chiefly on the marly loams of the Tertiary deposits, but the better-known wines grown for export are produced mainly in Gironde: Graves, Médoc and Blaye, Sauterne and Barsac. Here the vine covers most of the land, and the holdings are relatively large. Much of the export of this region goes to Latin America. The Gironde district is the only large-scale wine-producing district among the high-grade wine areas.

The Loire valley and the Rhône-Saône plains produce in much smaller quantities, but their wines have a high value. On the chalk slopes of the Loire valley and of its tributaries the sparkling white wines of Vouvray and Chinon are grown. In Anjou, Angers, Orléans and Saumur are the wine centres.

In the Yonne basin and the Aube, on the lower limestone slopes of Barrois, are the well-known vineyards of Chablis and Les Riceys.

In Champagne profitable vine cultivation reaches its northern limit, thanks to the warm chalk slopes in the Marne valley and at the foot of the Tertiary escarpment. Aspect and warmth of soil, as well as the relative dryness of the centre of the Paris basin, are the important physical factors concerned here. In the Rhône-Saône basin we find the same conditions—warm, calcareous soils, well-drained slopes, south-eastern aspect, where

the tiny vineyards stretch between the high-road and the steep edges of the hills of the Côte d'Or and Beaujolais, above places bearing names of world renown—Chambertin, Beaune, Mâcon, Beaujeu, Tain l'Hermitage, and others.

The white wines of Alsace are grown on the loess soils that cover the sedimentary rocks of Jurassic limestone at the foot of the Vosges, and particularly in the bay to the west of Strasbourg

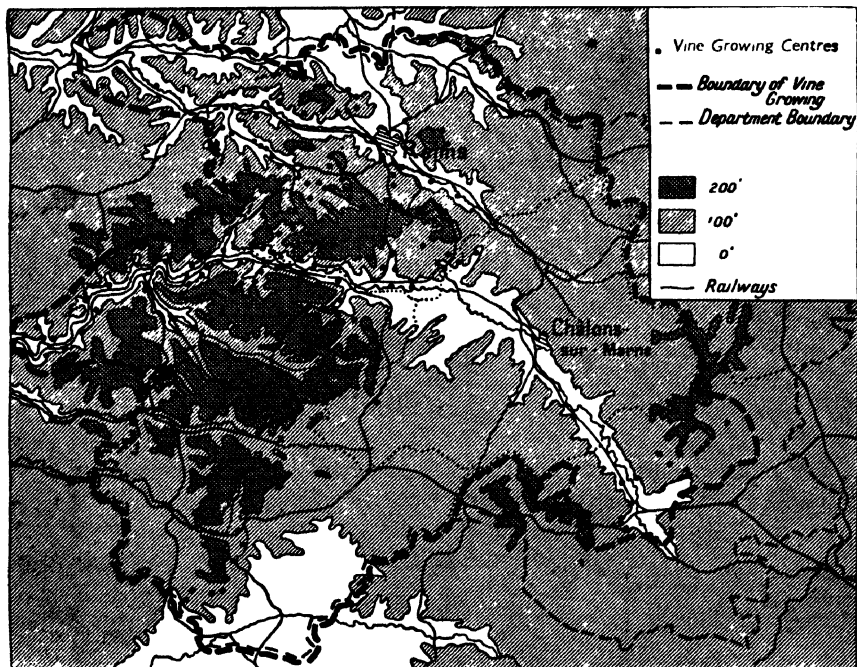


FIG. 79. CHAMPAGNE WINE INDUSTRY, SHOWING THE SITUATION OF THE VINE VILLAGES ALONG THE TERTIARY AND CRETACEOUS ESCARPMENT EDGES

and in the eastward opening valleys of the Vosges.) Here the vines get abundant sunshine, for they lie in the lee of the hills, and winds from the west must descend into the Rift Valley. They are not low enough to experience the chilling effect of the cold air that accumulates in the floor of the Rift. Naturally the vine cultivation diminishes in quantity and quality towards the north of Alsace. The wines of Alsace, like those of Côte d'Or are well adapted for export, and carry, among others, the names of Tokay and Muscatel, Riesling and Türkheim. Red wines are also made but are much less widely distributed.

Lorraine lies on the borderland of successful vine cultivation.

The crop is a very speculative one here on account of the elevation and the consequent bleak and uncertain climate. Where it is grown at all successfully we find it occupying the usual position at the foot of limestone escarpments with a south-easterly aspect. The drainage of agricultural labour to the mines has affected the output.

Apart from the south- and eastward-facing limestone slopes with which France is so peculiarly favoured in many districts, perhaps the most important factor in the wine industry is the

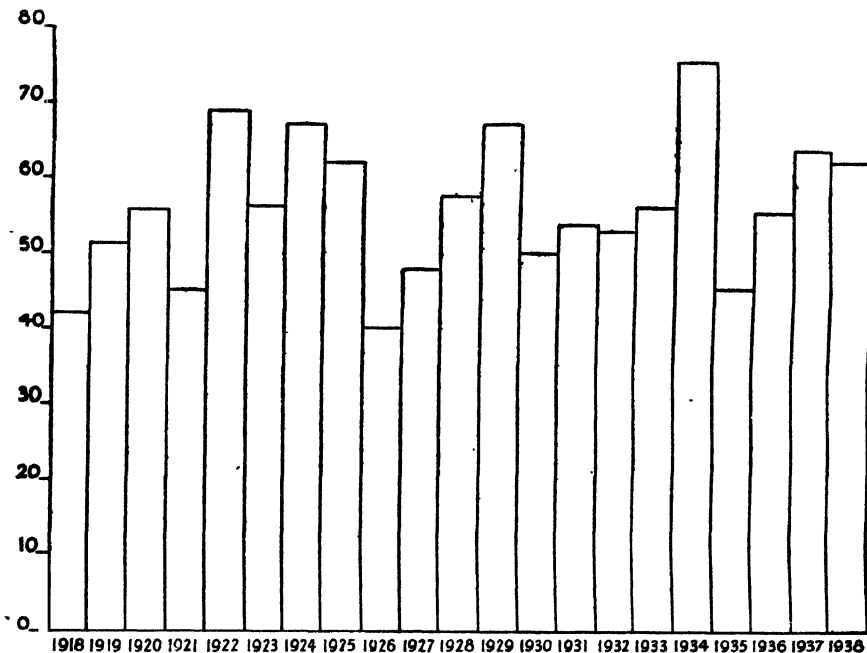


FIG. 80. ANNUAL PRODUCTION OF WINE IN FRANCE, TO SHOW THE FLUCTUATIONS FROM YEAR TO YEAR

presence of local highly-skilled labour, with a traditional technical knowledge peculiar to each type of wine. (It takes six years for a vineyard in Champagne to produce a high quality wine.) The yield of wine varies greatly with weather conditions from year to year, and the quality often varies in inverse proportion to the yield, a wet summer increasing the juice of the grape but diminishing the proportion of sugar content.

The cultivation of the vine has passed through several serious crises, of which the worst was the phylloxera pest that was imported from the United States. Some areas were completely devastated. Much land went out of cultivation and many vine-

yards were given up in favour of other crops. The disease was stemmed by various methods, and a start was made again by grafting French vines on to American stocks, which are more or less immune from the attack, and the acreage under vines steadily increased. The year 1854 was one of minimum production, and a maximum was reached in 1875, when the vintage was 83·8 million hectolitres. After 1918, a restricted foreign market, due to American prohibition, then the world depression, and greatly increased English excise duties, was severely felt, and a home market in which Portuguese, Spanish, Italian and North African wines compete, caused signs of a danger of over-production. Nevertheless, before the outbreak of the second world war general recovery was reflected in an increased production and the total of wine produced in 1934 (78 million hectolitres), was the second highest figure ever recorded. In 1938, the total was 60·3 million hectolitres.

Wine being the principal drink of the French for man, woman and child of all classes, except in the districts of the north and east and the cider district of the north-west, the home market for wine is very great, and enormous quantities of cheap wines are produced for home consumption. Many of these wines are of high quality but will not stand export, but every grade is manufactured. The high-grade wines are partly the result of peculiar local conditions, particularly of soil, but in the main are dependent on traditional skill in preparation, so that wine-making takes its place among the many 'speciality' occupations for which France is renowned.

CHAPTER XIII

INDUSTRY

WITH the re-acquisition of Alsace and Lorraine in 1919, France took her place among the great industrial nations of the world. This did not mean that she had undergone a sudden industrial revolution. It has been demonstrated¹ that the decade before 1914 witnessed a marked increase of industrial activity in France. Nevertheless the war undoubtedly stimulated industrial development, in spite of the tremendous losses it entailed in material and man-power. It gave full scope to invention, to initiative, to powers of organization, and it consigned to the scrap-heap much that was worn out and obsolete in both matter and method. The re-acquisition of Lorraine Annexée meant that France controlled by far the most important iron-ore deposits of Europe, together with a highly-organized and well-equipped iron and steel industry.

But France was still not pre-eminently a manufacturing country, and there is one vital geographical factor that is likely to hinder indefinitely her development in this respect. Her coal supplies are quite inadequate for her normal consumption, and particularly is she deficient in coal suitable for the production of metallurgical coke. The temporary possession of the coal-mines of the Sarre basin did not solve this difficulty, for though they provided an additional 13,000,000 tons per annum, they are capable of supplying only a negligible amount of coking coal. The position in this respect was even worse than it was before 1914, because of the great demands made by the newly-acquired metallurgical industry of Lorraine, and accounts for the great efforts made in the 1918-38 period to develop hydro-electric power on a large scale.

(As in other countries, the localization of industry in France depends on four main factors: the distribution of water, steam-power units, and hydro-electric power; the development of means of communication by water, rail and road; the availability of skilled and/or cheap labour; and easy access to raw materials, particularly iron-ore. Of these factors, the distribution of power is undoubtedly the most potent.) A consideration of Figs. 81 and 82 will show at a glance the preponderating importance of the

¹ Ogburn and Jaffé: *The Economic Development of Post-War France, 1929*, p. 13.

industrial region based on the *northern coal-field*, whether the power used be electricity or steam. The presence of coal in important quantities is not, of course, the only geographical factor concerned. The continuation of the coal-field across the frontier into Belgium, Holland, and Germany, and the narrowing of the north European plain between the upland and the sea,

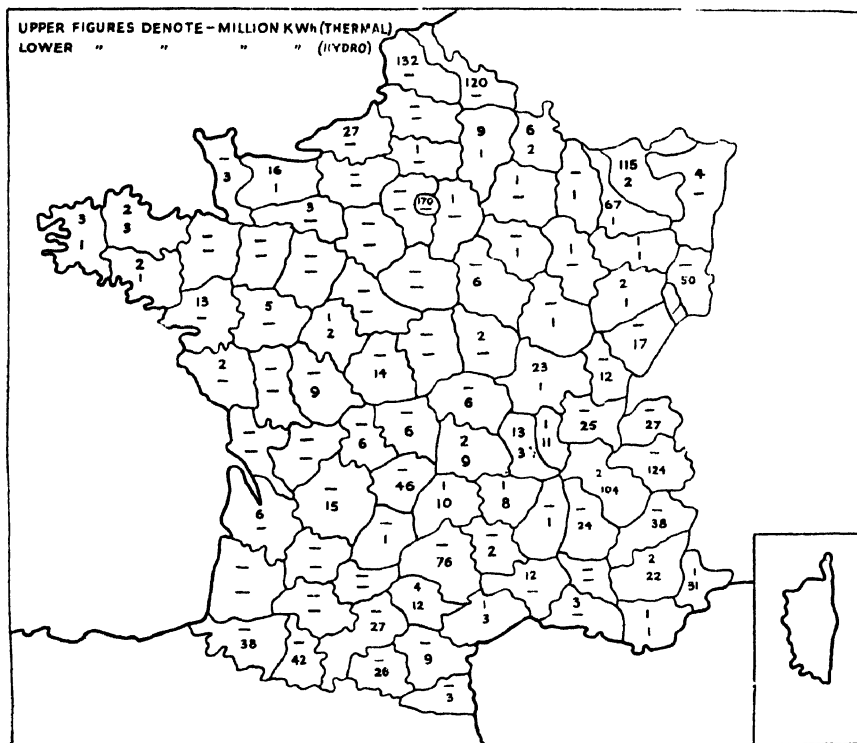


FIG. 81. PRODUCTION OF THERMAL- AND HYDRO-ELECTRIC POWER 1936, BY DEPARTMENTS

forcing the convergence of international routes, and, finally, the proximity of Paris and the Channel ports, must all be taken into account.)

(That the textile rather than the metallurgical industry should be dominant on the northern coal-field may be attributed partly to the presence of the traditional woollen and flax industries established in the Middle Ages and partly to the paucity of good coking coal in the French Flanders basin. The coal-mining and coal-distributing industry is enormously facilitated by the

excellent network of railways and the admirable canal system which links Belgium and the Paris area with the coal-field. Power and transport facilities are the more potent agents of localization in this region.)

(The next region in importance as regards the consumption of power in industry is that of *the East*, based on the Lorraine iron-field and, but to a minor extent only, on the Sarre coal-field. Here the metallurgical industry is predominant and the textile industry takes a secondary place.) Owing its origin to water-power derived from the Vosges, the textile industry has remained related closely to the Vosges valleys, where skilled labour is traditional, and has not been drawn to the coal-field. The presence of the raw material is the dominant factor so far as the metallurgical industry is concerned. The East industrial area is responsible for 90 per cent of French iron-ore production (in Lorraine) and, if the Ardennes and Haute-Marne departments be included, for four-fifths of the production of pig-iron, three-quarters of the raw and part-finished steel rails, cast iron and hollow-ware. It stands second to the northern area of Lille in textiles. Mulhouse in Alsace makes the bulk of the French cotton thread and stands first in France for calico-printing. Lorraine salt mining is the basis of important chemical industry and local sands play a part in the production of fine glass.

The third industrial region of France may be called *the Lyons region*. It is in some ways the most interesting of the industrial regions of France, for it is perhaps the most typically French.) The industry exhibits but little concentration in structure. It spreads over the whole middle and lower Rhône basin and laps over into the basin of the Loire. It may be said to radiate from Lyons¹ rather than to concentrate upon the town. The main arteries of its activities run through the plains of the Saône and middle Rhône, but they circulate also in the Alpine and Auvergne valleys and in the basins of the upper Loire. This diffusion of industry over a wide area is due in the first place to the scattered nature of the sources of power. The small coal-fields of Givors-St. Etienne and Le Creusot-Blanzy, the still smaller fields of Grand Combe, of Brioude and Issigny, have made possible a supply of power over a wide extent of country to a series of industrial oases which obtain their labour from regions of agricultural poverty. Similarly the Alpine torrents supply power locally to scattered valley industries in Savoy and in the Jura. These industries are tributary to Lyons in so far as they are concerned with the textile industry, and, to some extent, as regards chemical and

¹ See p. 288.

metallurgical industries too.¹ Silk, the raw material of the major industry, is partly a product of the middle and lower Rhône valley, but for the most part reaches the mills from Italy and the East via Marseilles, which thus, in a sense, belongs to the region also. Valence and Val manufacture rayon.

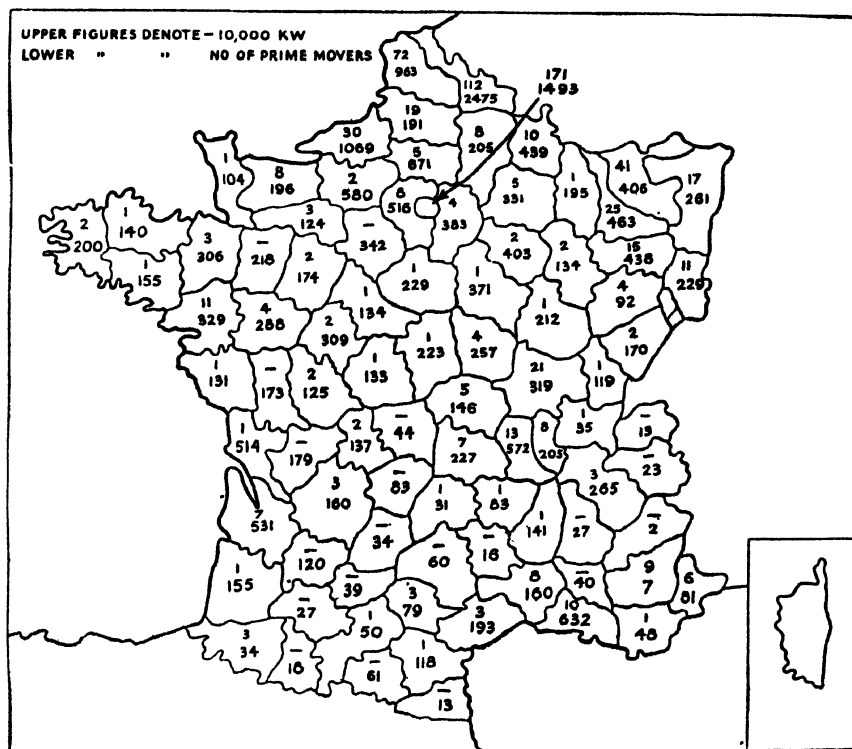


FIG. 82. PRODUCTION OF STEAM-POWER USED FOR MACHINERY, 1936, BY DEPARTMENTS, EXPRESSED IN TERMS OF POWER DEVELOPED.

Another region of 'radiation' is that of *Paris*, which differs, however, from the Lyons area in almost every other respect. Here the vital factors have been the concentrating routes and the traffic facilities that pertain to a great metropolis in the first place, and the highly-skilled labour of almost every type that such a great centre always commands. To these controlling

¹ Apart from the manufacture of silk and rayon, Lyons has multiple industries of which the chemical and engineering works are related to the coking and textile industries respectively; but motor and munitions works are also important.

geographical facts must be added the natural and artificial water routes that converge on Paris from the direction of the Channel and the Nord. Along the Marne and Oise, becoming more and more numerous as Paris is neared, are factories of all kinds, and within Paris a great multitude of artificers are engaged, not only in making those *articles de luxe* for which Paris has long been famous, but in all kinds of light engineering, including the manufacture and assembling of motor-cars. Rouen, as the port of Paris, supplying the metropolis with coal, oil and building material, forms part of the Paris complex. But it is also the centre of an industrial region whose port is Le Havre. The whole of the lower Seine valley is industrialized, and here, as in the instance of the Lyons region, though textile fabrication is the main occupation, other industries, such as chemical works and light engineering have grown up. Water-power and wool from the plateau of Caux were the geographical factors that encouraged the early growth of the woollen industry in the lower Seine basin. For the cotton industry both power and raw material have to be imported, but the position of Le Havre is favourable for the import of raw cotton, and colliers from Great Britain can navigate the lower Seine to Rouen.

The industrial region of the *lower Loire*, with Nantes as its centre, has developed greatly with the construction of the modern port of St. Nazaire. Ship-building and metallurgical industries have grown rapidly, based on imported coal. On the middle Loire the small coal-field of Commentry-Fourchambault was the basis of the metallurgical works at Montluçon and in the neighbourhood of Nevers. These were originally supplied by the Berry iron-field, but this is not worked to any extent to-day, and iron is now sent from Neuves Maisons in Lorraine and coal from the Le Creusot-Blanzay field supplements local supplies.

Scattered industries based on local traditional skill and cheap labour still flourish in France in the uplands, partly as a result of the direct policy of the French Government, which aims at preventing an undue exodus from the country to the town, and partly owing to the timely aid of hydro-electric power. The upland regions of France have always fostered skill in certain industries, e.g. wood-carving, watch- and jewellery-making, toy-making, textile and lace industries. These upland village industries developed because of the meagreness in these districts of the return from agriculture, and also partly because of the long, enforced cessation from field-work in the winter season. (To-day cottage industry is tending to give place to factory industry, but the installation of electric power in the home has made possible not only its survival but its recrudescence and even extension in

certain regions.) Moreover, factories, thanks to the easy transmission of electric power, are developing in the villages of the upland valleys, so that a stage is procured, if not a stop, to the emigration of labour from the agricultural and pastoral uplands to the towns.

(Just as, after the Franco-Prussian War, migration of the textile industry took place from the eastern Vosges valleys to Lorraine, Belfort and the northern Jura, so in the war of 1914-18 the invasion and occupation of the industrial area dependent on the northern coal-field led to a dispersal of industry into the interior of France. Advantage was taken of small groups of skilled labour and industrial equipment up and down the country and as far removed from the danger of air-raids as possible, and these became the nuclei of armament and munition works that expanded to enormous proportions to meet the needs of the army. Bourges is an example of the sudden galvanizing into feverish activity and the rapid expansion of a quiet agricultural centre. Unsited, owing to geographical conditions of location, to compete with more favourably placed centres, it nevertheless had retained, as a relic of its medieval reputation for cloth-making, a small textile industry and metallurgical works of no great account, which represented the remnant of activities during the intensive working of the iron deposits of Berry. Its revival in 1914-18 was only transitory, however, for the local military arsenal became the heart of the war-time expansion, and the town speedily shrank into its former restricted orbit of interests with the cessation of hostilities and the withdrawal of the hordes of foreign workers for whom it had catered and organized.¹

(Elsewhere industrial expansion has been of a more permanent nature.) The Rouen industrial district, for example, reaped permanent advantages from the war of 1914-18, particularly in its port and railway facilities, which had to be greatly expanded to meet the needs of the British Expeditionary Forces, of which Rouen was the base, and which have been of great value since to the port and to the textile districts that lie about it. The textile industry, particularly that of cotton and linen, received a very great impetus, and the benefits of the re-equipment which the industry underwent will be felt for a long time. The region also had the advantage of the high-grade skill of Lille manufacturers and workmen, who introduced manufactures and methods until then unpractised in the district. Chemical and dye-works, metallurgical-works, ship-building yards, all owe their establishment to the energy of extraneous enterprises whose main centres in certain instances were either put out of action or overloaded

¹ C. E. Gignoux : *Bourges pendant la Guerre*.

as a result of the war of 1914-18. Even the cultivation and retting of flax, which had been a moribund industry, has been given a new lease of life owing to the cessation of imports from Russia.

Let us now consider the geographical setting of the major industries, with the idea of summing up and correlating material already dealt with in the detailed study of the regions. We will consider first the coal-mining industry.

COAL

(France's production of coal is inadequate for her needs.) The annual production of coal¹ between 1931 and 1938 was between 46 and 48 million tons; the 1939 output was a little higher, 50·2 millions. Imports² amounted to some 22 million tons in 1939, making a total for home consumption in that year of about 72 million tons. Even during the fifteen years' possession of the Sarre mines, the position was only slightly improved, some 20 per cent being added to the 1913 total. Moreover, Sarre coal is not of the caking quality that lends itself to the production of metallurgical coke, but requires the costly process of hydrogenation or the use of an admixture of Westphalian coal; and, owing largely to the marginal position of the field, was most economically utilized locally or marketed in South Germany and Switzerland. But it must be remembered that the south-western extremity of the Sarre field, now lying within French Lorraine, probably contains about one quarter of the total Sarre reserves. The French have re-equipped and worked this section heavily since 1918. In 1936 the output was 5·4 million tons, i.e. 55 per cent more than in 1913. It serves to some extent the Lorraine metallurgical district, as well as the Vosges textile areas. Local domestic requirements are supplied and small quantities pass into central France. The rest is exported to central Rhineland, to Switzerland and to Italy.

(The amount of coal imported fluctuates greatly from year to year. This is partly due to divergence of interests of the importing ports (Rouen in particular) and the mining companies, and partly

¹ Approximate coal production (including lignite) in million tons.

1913	1925	1930	1935	1936	1938	1939
44·65	48·10	55·06	47·12	46·17	47·56	50·24

² Imports as a percentage of total fuel consumption.

1933	1934	1935	1936	1937	1938	1939
34	32	30·5	33·5	40·5	34·5	22·0

to changing economic conditions.) Reconstruction and modernization of colliery equipment in northern France was completed by 1924 and production rose to a peak in 1929 (see Fig. 83). By

COAL
(Consumption in mill:tons)

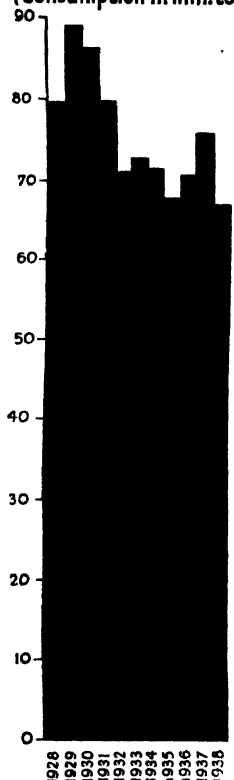


FIG. 83.

Data for these and following graphs are taken from the *Annuaire statistique* for 1938. (Paris, 1939.)

COAL (Sarre excluded)
(Production in mill:tons)

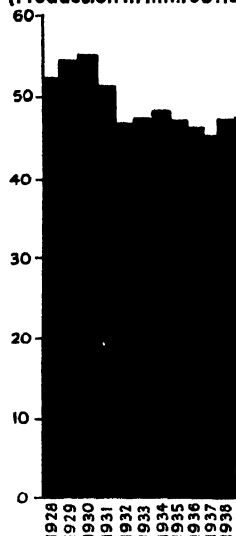


FIG. 84.

SARRE COAL
(Production in mill:tons)

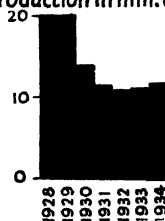


FIG. 85.

1935 it had dropped again) by 24 per cent to a total of 67.8 million tons.

(Coke. Of metallurgical coke for foundries France produces a considerable proportion of her requirements. In 1938 she consumed 6,601,770 tons of metallurgical coke, about 5 million

tons of which was produced within the country. Large quantities of non-metallurgical coke are manufactured by the gas companies to supply the large centres of population such as Paris and Lyons and those in the northern coal-field: but small quantities of good coke are manufactured in the St. Etienne district (see page 42). (Coke production in 1936 amounted to 7.1 million tons, while 2.6 million tons were imported. In 1939 production rose to 8.2 million tons.)

Thus France had to import about 30 per cent of both coal and coke consumed.

The provenance of the imported fuel is related to the relative geographical situation of the coal-fields of neighbouring countries. British coal, normally accounting for more than half the coal imported, enters at most of the ports but chiefly via the Seine, Loire and Garonne. Coal from the Aachen and Ruhr coal-fields enters mainly via Belgium, but Ruhr coal is also imported via Dunkirk and Rhinewards to Strasbourg. Good coking coal from the Dutch and Belgian Campine fields has been imported in increasing quantities, both overland and by the Rhine. Of coke imported in 1936, about 84,000 tons came by sea, 291,000 by canal, 1,372,000 by the Alsace-Lorraine railway, 769,000 by the Est railway and 26,500 by that of the Nord (see p. 460). (For movements of coal in the direction of Paris, see pp. 481-4.) German coke is railed, either by the Moselle valley to Lorraine or from the Sarre Territory. Some German coal comes up the Rhine to the cokeries at Strasbourg.

The northern coal-field of the departments of Nord and Pas-de-Calais is the only considerable coal-field in France and produced about 24 million tons in 1936. As we have seen,¹ the coal is difficult and expensive to mine, for the deposits lie in a very large number of seams, some of them less than fifteen inches thick, and everywhere much disturbed.² Generally speaking, that part of the field which lies in the Nord department is less productive than the western section, but good coking coal has been preserved in the upper seams in the Valenciennes district. Anzin, Raismes and Vieux Condé are the more important centres here. Farther west the coal becomes poorer, but improves again in the Denain-Aniche district. In the Douai district there are good seams of bituminous coal.

(The most productive part of the field lies in the department of Pas-de-Calais in the district of Courrières-Lens-Grenay, to the north of Arras. Here the seams do not dip so steeply as in the east, and there are fewer faults, so mining is easier. There are

¹ p. 195.

² In parts of the Nord field the seams dip at an angle of 40 degrees.

some very thick seams and various kinds of coal are mined—good bituminous coal as well as 'flame' and gas coal. Still farther west, in the Bruay-Marles area, there are rich mines producing gas coal.

The coal-field suffered enormous damage during the war of 1914-18. The Lens area was so severely shelled by the allies and the enemy that practically no stone was left upon another, and roads and railways were obliterated. But, worse still, the Germans

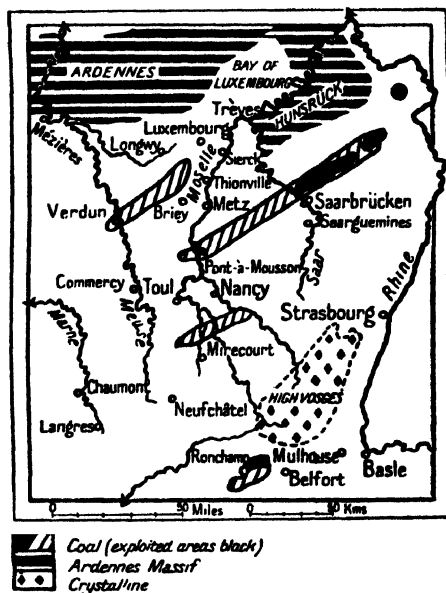


FIG. 86. THE SARRE AND LORRAINE COAL DEPOSITS. THE COAL IS ACTUALLY MINED JUST TO THE SOUTH-EAST OF THE SARRE, AND HAS BEEN PROVED AT GREAT DEPTHS AT PONT-À-MOSSON.

deliberately flooded the mines in 1915-16, and it was ten years before they could be restored to working order. Now, however, they are completely re-equipped on modern lines and their productive capacity is thereby improved. Continuous progress has been made in the use of mechanical equipment. In 1913 only 4.7 per cent of the coal produced was broken down by pneumatic picks, in 1927 the proportion was 65 per cent, in 1937 it had risen to 92 per cent. In the last decade, also, there has been a great increase in the capacity of coal-washers and the efficiency of dust and earth extractors.

(The production of metallurgical coke from French coal is

greatest in Pas-de-Calais,} where about 2,900,000 tons of local coal were consumed in this way, together with 55,000 tons of foreign coal: In the Nord department, only about 1·2 million tons of local coal were used for coking, but 220,000 tons were imported from and by way of Belgium for this purpose. The amount of coke produced there was less than half that in Pas-de-Calais. (Great efforts have been made of late years to increase the output of metallurgical coke on this coal-field.)

Movements of coal from these two departments are very important by both rail and water. Douai is the chief expediting centre,² whence household, steam and coking coal to the amount of about 2,000,000 tons are sent by the St. Quentin and Oise canals and the canalized Oise in the direction of Paris, and by rail in all directions. Owing to difficulties of transport, however, southwards across the Ardennes Massif, the Meuse basin is supplied from Belgium.

The output of the chief collieries in Nord and Pas-de-Calais in 1937 (millions of metric tons), is given in the following table:

<i>Nord</i>		<i>Pas-de-Calais</i>	
Courrières	3·05	Bruay	2·57
Aniche	3·02	Vicoigne-	
Anzin	2·98	Noeux-Drocourt	2·37
Lens	2·75	Marles	2·30
		Béthune	2·00

The modern tendency has been towards amalgamation and the working of the mines by large-scale units. The table above shows that eight colliery companies are each producing more than two million tons of coal each in 1937, roughly two-thirds of the entire output of France.

The south-western extremity of the Sarre coal-field, lying within French Lorraine, probably contains about one-quarter of the total Sarre reserves. Coal is mined in the valley of the Rosselle, a left-bank tributary of the Sarre (the Petite-Rosselle mines), and in the valleys of the Merle and Bisten. The district produced about 5·4 million tons in 1936, which is 55 per cent more than in 1913, and 6·7 million tons in 1938, owing to the re-equipment of the mines under the French régime. The district serves to some extent the Lorraine metallurgical industry and the Alsace and Lorraine textile areas of the Vosges. Local domestic requirements are supplied and small quantities pass into central France. The rest is exported normally to the German Rhineland, to Switzerland and to Italy.

¹ There were 1,493 coking-ovens in Pas-de-Calais as against 692 working in Nord in 1936, but the Nord coking-plants are larger and more up to date.

² See Fig. 96 in Chap. XIV, p. 475.

The small coal-fields that lie in the fissures and furrows of the *Central Massif* are of but local importance, with the exception, perhaps, of the Loire coal basin, where the St. Etienne and Rive de Gier mines produced about 3,240,000 tons in 1936. Unfortunately the coal here is expensive to mine on account of the disturbed nature of the beds. Nevertheless the deposits are important, for certain beds yields high quality coking coal for metallurgical purposes, of which about 400,000 tons is coked locally. Some of the high-grade coke is sent to Lorraine. There is some output also of gas coal, which supplies a number of gas-works in the neighbouring industrial centres. From this basin nearly 500,000 tons are supplied annually to the P. L. M. railways, and coal is sent to the hydro-electric stations of the Lyons district, to supplement the water-power in the dry seasons.¹ Over a quarter of the coal produced is used in the locality in the metallurgical and textile industries. Small quantities of coal are produced in the neighbouring Roanne district and at Ste. Foy-l'Argentière on the Roanne-Lyons line.

The coal basins of Burgundy and Nivernais produced about 2,300,000 tons per annum. The only important mines here are those of Le Creusot and Blanzay which produce over 2,200,000 tons. Much of the coal is bituminous, but steam and gas coal are also mined. Epinac and La Chapelle-sous-Dun in Saône-et-Loire and Decize in Nièvre produce small amounts. The Burgundy and Nivernais basins supply the Le Creusot works and the metallurgical industries of Nièvre. The Blanzay mines have direct access to the Canal du Centre, and are well served by rail.

The Alès mines, in the departments of Gard and Ardèche, had an output of just over 2,000,000 tons per annum, and supplied the small industrial region at the foot of the Cévennes, with the centres of Alès, Grand Combe, and Bessèges, which have metallurgical and machine-making industries.

The only other basin that had an output exceeding 1,000,000 tons per annum was that of Carmaux and Albi, in the department of Tarn, which produced just over 1,000,000 tons in 1936 and serves the wool mills of Castres and Mazamet. The basin of Aubin in Aveyron, where the annual output is about 600,000 tons has given rise to the industries of Tulle, which makes armaments, and to the metallurgical works of the Aubin-Firminy-Decazeville area.

The small basins of the Auvergne in the neighbourhood of Brassac (Puy de Dôme and Haute-Loire) have an output together of 890,000 tons only, and supply Clermont-Ferrand. Farther

¹ During 1914-18 it was established that the coal basin of St. Etienne extended to the left bank of the Rhône, and it is actually mined at Ternay and Communay. The output is very small at present.

north the Bourbonnais coal furrow of Commentry-Fourchambault produced about 900,000 tons, and was important in the development of the metallurgical region of the Centre. Montluçon is now dependent on Lorraine iron and Le Creusot coal.

(These small coal-fields of the Central Massif have difficulty in marketing their coal to-day.) They were worked to capacity during the 1914-18 war, as also were the metallurgical and other industries based upon them. St. Etienne,¹ Firminy, Unieux were very busy after 1918 in providing material for the reconstruction of the devastated north. Owing to the completion of this work and the increasing use of electric power, not to mention the economies introduced in the utilization of coal, the demand has fallen off. English coal, which enters via Bordeaux, is cheaper in the Limoges district than Champagnac coal from the department of Cantal. Even Sarre coal is cheaper because it can be sent by canal.²

In spite, then, of being obliged to import such large quantities of coal and coke, France is, nevertheless, over-producing in certain areas. Here once more the geographical control is evidenced in the cost of transport. (The coal that France produces in her two larger coal-fields is largely of a domestic type.³ Domestic coal is distributed in relatively small amounts, and therefore travels mainly by rail. The main coal-fields of France lie on the borders, and the small scattered fields lie in the southern half of the country.) Paris is 120 miles from the northern coal-field, and British seaborne coal, coming via Rouen, can compete successfully with coal travelling by rail and canal from the north.

ELECTRICITY

The total installed generating capacity of France in 1938 was about 11.25 million Kw, of which seven and a half million were normally available, the remainder being held in reserve.)

Until after 1918, the main source of power generation was by means of coal-raised steam-driven turbines. Plant for thermal generation of current has the advantage of being more cheaply installed than hydro-electric plant. It has also the advantage that inferior coal, blast-furnace and coke-oven gas, and cheaply mined or quarried lignite can be used in the generating process. Moreover, a reliable supply of current can normally be obtained all the year round.

¹ The St. Etienne, Roche de la Molière and Firminy mines have important cokeries producing tar, sulphate of ammonia, and benzol products.

² L. G. Numille: 'L'Evolution de l'Industrie Houillère' (*L'Economiste Français*, February, 1929, p. 165).

³ Small quantities of anthracite are mined near Fango in Corsica and near Grenoble.

Hydro-electricity, on the other hand, offers the advantage that running costs are relatively small, although the initial installation, if a head of water has to be artificially provided and maintained, is high. A serious drawback is that owing to seasonal change in the volume of water supplies utilized, there is apt to be a deficiency of water for the turbines, and recourse must be had to thermal means to keep up the requisite supply of current during winter frost and summer and autumn drought.)

Thermal Electricity. The main generating stations are situated on the coal-fields and at coal-importing ports, e.g. Paris, which has the most powerful electric supply potentiality in the country, Rouen, Lille and Strasbourg. Even the small coal-fields of the Central Massif, those of Ronchamps in the southern Vosges and of la Mure on the Isère have their electric plants. Lignite deposits are used in Gironde and Bouches-du-Rhône. On the iron-fields of Lorraine and of Caen blast-furnace gas is used to generate current. Local demands encouraged development, for electricity is increasingly used in the mining and metallurgical industries for lighting, for driving machinery and for smelting.

Hydro-electricity. (France, in her extensive mountain regions, has great potentialities for the development of hydro-electric generation, to say nothing of the rivers Rhine and Rhône—her two largest potential sources of power. The main difficulty and cost of installation lie in the provision of water storage, for the Alpine sources are closed by frost in winter, and the French Alps are less well supplied with natural reservoirs than the mountains in either Switzerland or Italy. The run-off from the Archæan rocks of the Central Massif is rapid and often torrential, and there is very little natural storage capacity. On the other hand the narrow *cluses* of the Alps and of the Jura and the deeply-incised gorges of the Central Massif lend themselves to the construction of barrages and to the creation of artificial lakes. Such are the reservoirs of Brommat and Sarrans in the Lot basin, of Marèges in the upper Dordogne valley, and of Eguzon on the Creuse.)

Up to 1935, thermal electricity supplied a larger proportion of the country's supply than did hydro-electricity, but from 1933 onwards hydro-electricity made great strides. The heavy demands made on the coal-fields by armaments during the war of 1914-18 and the German occupation and subsequent devastation of the colliery areas, together with the post-war high price of imported coal, combined to cause a decrease in the use of steam generation and a corresponding increasing reliance on hydro-electricity. Production in some of the largest thermal installations, those of Paris for example, has been more or less suspended.

(The development of hydro-electricity has led to a much wider

distribution of current, and only about one per cent of the population is without electric light.) Consumption per capita (458 kWh in 1938) is equal to that in Britain, but lags far behind that in Sweden, Switzerland and Germany.

(Elaborate projects have been made for the utilization of the swift and voluminous currents of the rivers Rhine and Rhône.)

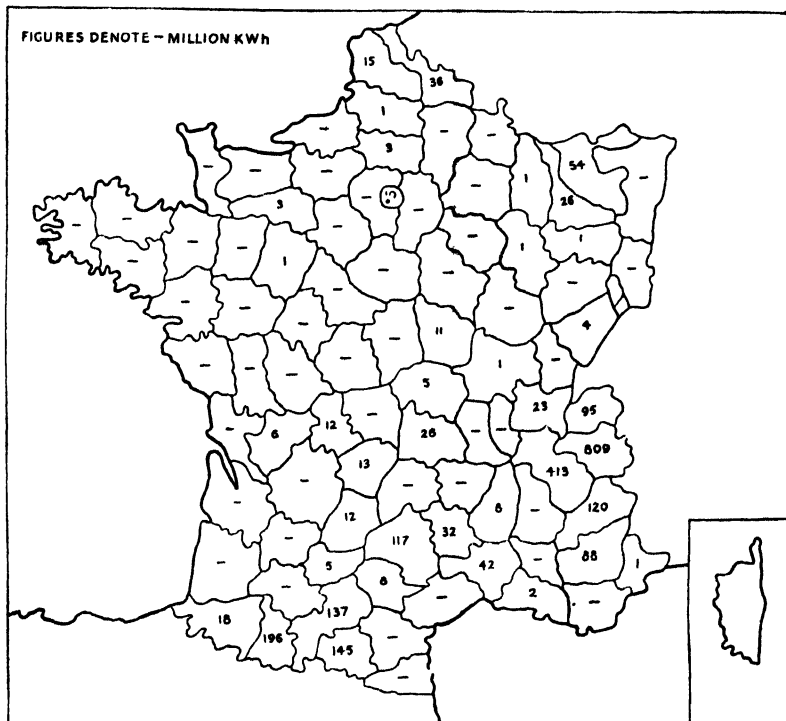


FIG. 87. ELECTRICAL ENERGY CONSUMED IN CHEMICAL AND ELECTRO-METALLURGICAL WORK, 1936, BY DEPARTMENTS.

(Based on figures in the *Annuaire Statistique*, 1939)

On the Rhine, the Kembs barrage station, the first and so far the only instalment of the power scheme planned to accompany the construction of the *Grand Canal d'Alsace*, was completed in 1933, and has a capacity of 150,000 kW. A smaller station (72,000 kW), has been installed at Port du Rhin (Strasbourg).

(The Rhône project has had much publicity but the funds for its realization have not been forthcoming.) It has been estimated¹ that a canalized Rhône would provide 900,000 kW, the power equivalent of five million tons of coal per annum.

¹ Marcel Koch, 'Les Grands Ports Européens,' in *La Navigation du Rhin*, July 1929.

In the Eastern Highlands the utilization of hydro-electric power is particularly high in the northern Alps, and the southern Jura supply the south-east (Lyons, St. Etienne and Grenoble) and the factories of Tulle and Embrun in the Durance valley. This supply is supplemented by the thermal stations of St. Etienne, Givors and Jonange (north of Lyons).

In the Central Massif a number of new and important stations were constructed between 1934 and 1938—Brommat, Marèges, Eguzon, Sarrens, Vintrou and Chambon, and a score of other stations were projected or under construction. The function of these new stations was chiefly to supplement supplies to the large industrial centres.

In the Pyrenees, the Gave d'Ossau, the Gave de Pau and the torrents of the upper Garonne and its tributary the Vicdessos, supply three groups of stations, power being distributed from Laruns and Lannemezan. The glacial lakes of the High Pyrenees form useful reservoirs and the abrupt gradient of the valleys on the French side provides a good head of water. These stations serve small electro-chemical and electro-metallurgical works and supply the electric railways.

Modern technique, facilitating long-distance transmission of current, has made it possible to organize a great network of transmission lines over the country, so as to link up thermal and hydro-electric production plants of varying types and capacity and to synchronize and control the output and distribution. The bulk of the electricity production in the country is now under the control of this organization.

IRON-MINING AND THE IRON AND STEEL INDUSTRY

The iron mines of France produce annually about 33,000,000 tons of ore, of which about 32,000,000 come from Lorraine. Before 1914 the total output of ore in France was about 22,000,000 tons, of which 9,500,000 tons were mined in the Briey plateau. In 1930, as the result of the restoration of Lorraine *Annexée*, France stood second in the world in the production of iron-ore, second in the production of pig-iron,¹ and third in the manufacture of steel, having taken the place held by Great Britain in 1913. From 1918 her production of pig-iron and steel rose steadily till the beginning of 1930, when the depression already experienced in other countries began to be felt. Between 1932 and 1936 production of both pig-iron and steel declined to about 6 million

¹ In 1930 France out-distanced Germany in the manufacture of pig-iron, taking the second place after the United States of America.

tons. With the increase in the needs of the armament industry, in 1939 the output of pig-iron and steel totalled 7·4 and 7·9 million tons respectively.

(We cannot emphasize too strongly the importance of the great Lorraine iron-fields—the largest in Europe and second largest in the world and the most economical to work. Although iron-ore is to be found in the sedimentary rocks of almost every part of France, it is only in Lorraine that the ore is present in large quantities, and in a position and under conditions that make it worth while to exploit on a large scale.) Before 1870, when the Franco-German boundary ran as at the present day, there were forges in Ottange, Hayange, Moyeuve and Ars-sur-Moselle, near the north-eastern extremity of the iron-field. The development of the field was going on apace, and the Wendel firm had already set up forges on the Sarre coal-field, the extreme south-western portion of which lay within French territory. In 1872 the Treaty of Versailles drew the frontier so as to include within Prussian and Bavarian territory the greater part of the then worked coal basin of the Sarre and the whole of the then worked iron-field. The French subsequently discovered and developed the iron-field of the Briey plateau and of Nancy.¹

From the point of view of accessibility, the Lorraine iron-field is not well placed. It is too far away from the sea, and it is far from the nearest satisfactory coal supply. It is even 120 miles away from the international Rhine, which, although providing cheap transport, is not by any means reliable as a carrier.² Fuel, ore, pig-iron and manufactured steel must therefore be transported in the main by rail, and it is here that the peripheral situation of Lorraine is adversely felt.

On the Sarre coal-field, before 1914, important plant were smelting and working up Lorraine ores, utilizing Sarre coal with Westphalian coal and coke which was railed from the Rhine. Thus iron-ore and pig-iron were brought to the coal-field, and metallurgical coke and coking coal were imported to use with the local coal. On the German part of the iron-field also a metallurgical industry had sprung up in the Thionville area. Here too there was much smelting of iron-ore, but there were also important iron- and steel-works, although only 17·6 per cent of the ore went to works near the mines, the rest being sent away chiefly by rail. (There was an important exchange, via the Moselle valley railway, of Lorraine ore and pig to the Rhine coal-field, and Westphalian metallurgical coal and coke to the iron-field.) The trucks that

¹ See p. 348 et seq.

² The Rhine does, however, greatly cheapen the carriage of coal to the coking and distributing centre of Strasbourg, and the canals are of some use in further distribution to the iron-fields.

brought up the coal or coke carried back ore or pig to Westphalia.¹ The Moselle river is not used for transport, partly because of the poor navigation facilities that it offers, and partly because it is essential that metallurgical coke in the modern foundries should not be crushed, and it travels with less man-handling by rail. As a result of this barter transport we find coking, smelting, cast-iron and steel-making developing not only on the coal-fields but in the valleys of the iron-field also.

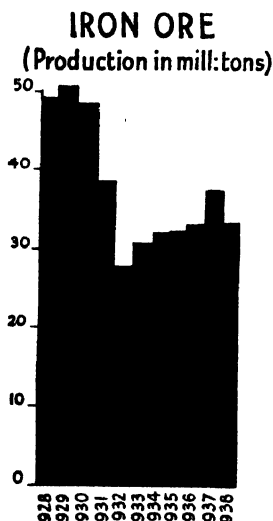


FIG. 88.

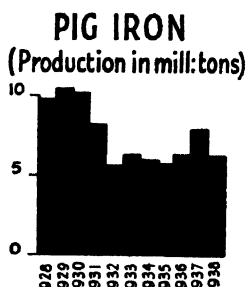


FIG. 89.

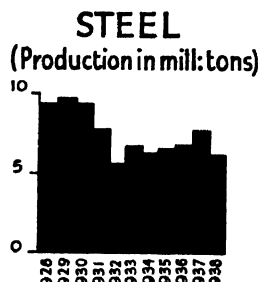


FIG. 90.

The Briey iron-field in French Lorraine had not developed a steel industry of great importance, partly on account of the high cost of coal transport in this more easterly section of the field.) It paid better to export ore and to import enough coke only to manufacture pig-iron for export. In the detached portion of the iron-field the Pont-à-Mousson-Nancy districts carried through every stage of the industry from mining the ore to the manufacture of the finished article, for the ore is for the most part too friable to export and is non-calcareous, and it pays better to import the relatively small amounts of coal or coke necessary to smelt the ores, in order to make cast-iron and steel goods of a light

¹ A train of sixty wagons, bringing up coke or coal, could carry back the twenty-two wagons of pig smelted by the coke and thirty-eight wagons of ore for smelting in the Westphalian furnaces.

character. The finishing industries established themselves early in the Nancy area.

Fig. 63 shows the present geographical position of the Lorraine metallurgical industry. The boundaries emphasize the political and strategic situation. France had possession, until 1935, according to the provisions of the Versailles Treaty of 1919, of the Sarre mines (with the exception of the Frankenholz mines of the Bavarian Palatinate, which produce only 500,000 tons per annum), and of the coking ovens connected with them. She holds by far the greater part of the worked iron-field, leaving to Belgium and Luxembourg only the mines along the northern edge of the plateau. The 1936 production of pig-iron in French Lorraine was in the neighbourhood of 4.8 million tons.

The position as to the movements of fuel and iron in 1936 does not greatly differ from that of 1913, though there are one or two modifications worth noticing. First, the interchange of iron and fuel between Lorraine and the Ruhr is greatly below that of 1913. After a period of working intensively the rich but costly refractory ores of the Sieg basin and of importing relatively costly Swedish ores, Germany appeared to be returning to the more geographically sound arrangement sketched out above, but on a much smaller scale than before 1914, and with this difference, that the Moselle route was no longer paramount, and that interchange of ores, pig and fuel took place increasingly via Strasbourg, where also a considerable amount of the German coal was now coked *en route*.¹ In the meantime,² however, a closer liaison has been set up between the iron-fields of Lorraine and the coal-fields of the Nord and of Belgium.

Coking has become much more common on the Lorraine iron-field, and the utilization of Sarre coal for metallurgical purposes by a process of distilling and blending has passed the experimental stage. Steel-making on the iron-fields now equals that in the Sarre territory.³

The main difficulties that the iron and steel industries of Lorraine encounter are those of transport. An exchange of coal

¹ See p. 386 on Strasbourg coking industry.

² Under the Treaty of 1919, in order that the iron- and steel-works of Lorraine should not be too suddenly deprived of their pre-War markets, it was provided that, for a period of five years, there should be free entry of Lorraine products into Germany, to an amount not to exceed the average of the amounts sent annually into Germany in the years 1911-13. In November 1926 the important metallurgical groups of France, Germany, and Luxembourg concluded a rationing convention, which was later included in the International Steel Agreement. France and Germany are also both members of the International Rail Makers Association. It is interesting to note that, where artificial barriers are raised against the natural or geographical flow of trade, non-political agreements are made to overcome these barriers.

³ At Thionville electric furnaces have been set up to manufacture special steel.

and ore via the Rhine, between Strasbourg and Antwerp, has been brought about by means of special agreements, but the distance is great and the arrangement has no geographical stability. The rail route to the Nord coal-field is long and costly, and canalizing of the Meuse was undertaken with the idea of cheapening transport.¹ A recent effort to keep the transport within the French frontier and to encourage a French port has diverted a certain amount of traffic to Dunkirk.

The iron and steel industry of the north, having long ago exhausted the small supplies of local iron-ore available, depends entirely on imported metal, and we find therefore but a small production of pig-iron—about 840,000 tons—and a great development of the steel industry. Most of the iron- and steel-works are grouped in the Valenciennes-Anzin district, while the blast-furnaces are concentrated at Denain. It is in the eastern part, and near the Belgian frontier, that the greatest development of metallurgical industry on the coal-field has taken place, in spite of the fact that more metallurgical coke is produced in the west. Railway communications are better in the east, and here lies a great market for engineering products in the textile region on the Franco-Belgian frontier. Nord produced over 1,000,000 tons of steel and Pas-de-Calais about 100,000. (In finished steel products Nord also stands high,) with over 1,075,000 tons. Machinery-making, to supply the textile works, was an early development of the modern industry, but the making of heavier steel goods, such as plates, boilers, rails, etc., goes side by side with this. The motor industry naturally has its seat on the most important coal-field, and near to a port of export; but we have seen how its branches flourish in more remote parts of France.)

The iron-field of the Norman *bocage* is insignificant compared with the great Lorraine field. The annual output is only a little under 2,000,000 tons of ore. In spite of the distance from supplies of coking coal, and the fact that the type of ore, which is only semi-phosphoric, is not suited for the basic method of smelting current in France, a steel industry is being built up at Caen. Not much of the ore is used in France; most of it is exported by sea, mainly to the British Isles. The output of steel in 1936 was in the neighbourhood of 260,000 tons, and 490,000 tons of coking coal were imported for conversion into metallurgical coke. The port is at Hérouville on the Caen canal.

(Apart from the iron deposits already mentioned, iron is found in small quantities in the sedimentary rocks in almost every part

¹ Report of the Association of the 'Mâitres des Forges de Lorraine,' 1923, 1924, 1925.

of France, and before the introduction of steam-power the iron industry, being dependent on wood for fuel and water for power, was scattered widely, chiefly on the edges of the basin areas of France, where altitude and gradient ensured fuel and power and where the rocks contained iron. Thanks to the small coal-fields on the edge of the Central Massif, certain of these ancient iron workings were able to survive and develop. Thus we have the iron industries of the Centre, the Le Creusot and Nivernais works,

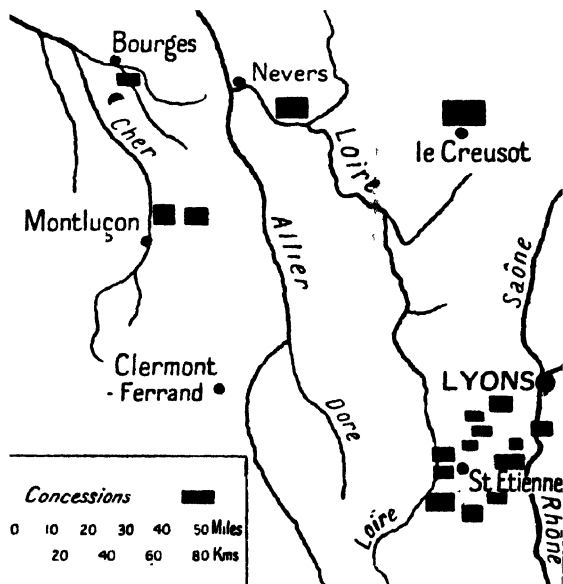


FIG. 91. THE METALLURGICAL DISTRICT OF THE CENTRE, SHOWING COAL MINING CONCESSIONS

based on the coal-field of Le Creusot. The ores of the Centre are worked out, or are too scattered in incidence to be worth exploiting to-day. But the iron and steel industries that they originated are still flourishing as a result mainly of economic inertia, for pig-iron has to be imported by a roundabout route, though coal from the Blanzey-Le Creusot field is more easily obtained. The steel-works of Nièvre specialize in hard steel, as, for instance, crucibles for glass moulding and parts of motor-engines.

The iron and steel industry of St. Etienne is based on the local coal-field. It manufactures no pig-iron now, but works up large quantities of imported metal and makes semi-finished goods. It has seventeen iron- and steel-works and made in 1936 some 50,000 tons of basic and acid steel. It has no less than eight electric furnaces deriving the necessary power from local coal-

mines and hydro-electric installations. Small arms, textile machinery, and other light engineering products are manufactured. The industry extends into the Rhône valley in the Givors-Lyons district, and into the Andaine valley, where Firminy and St. Chamond have large steel and engineering works. Lyons is the metal market for the region.

In Maine-et-Loire about 186,000 tons of semi-phosphoric ore, and in Orne another 111,000, were produced in 1936. It is not smelted locally. That of Orne goes to Caen, that of Maine-et-Loire to Nantes.

The Pyrenean mines, producing about 55,000 tons of non-phosphoric ore, are situated in the departments of Basses-Pyrénées and Pyrénées-Orientales. Between four and five thousand tons of pig-iron are produced from them locally. There are four smelting works in the Pyrenees, two in Hautes-Pyrénées, and two in Pyrénées-Orientales. Two electrical furnaces in Basses-Pyrénées and six in Hautes-Pyrénées use hydro-electric power. These furnaces make high-grade steel for special purposes. Only about a hundred men are employed.

Iron and steel bulked large in the exports of France before 1939. Belgium-Luxembourg was the largest importer of ore—importing 10.4 million metric tons in 1935 and 10.1 in 1936. Germany came next with 6,400,000 tons in 1935 and 7,800,000 in 1936. Holland was third, with about 800,000 tons in 1937. Belgium-Luxembourg was again the chief customer when pig-iron is considered. In 1937 she took one hundred and fifty thousand metric tons of pig-iron, and Germany followed with one hundred and fifteen thousand.¹ Great Britain, Italy and Switzerland are also important buyers.

But it is especially in semi-finished products that France has important exports. To Germany went between seven and eight hundred thousand tons, to Belgium-Luxembourg about five, to Great Britain amounts varying greatly from year to year, but reaching 900,000 tons in 1927 and 500,000 in 1928. Switzerland took between 100,000 and 200,000 tons. Exports of semi-finished iron and steel products fell considerably in the twenty years preceding 1938. The chief purchasers, in that year, out of a total of 1,376,000 metric tons, were Great Britain, 232,000 metric tons; Belgium-Luxembourg, 170,000 metric tons; Switzerland, 110,000 metric tons.

Considerable quantities of pig-iron and semi-finished products are imported from Belgium, but the trans-frontier movements of metallurgical products are so greatly influenced by tariffs,

¹ The provisional total of 238,000 metric tons in 1938 would give Germany easily the first place.

combines, etc., that it is impossible to estimate the effect of geographical influences in this connexion.

ALUMINIUM. France is the most important producer of bauxite, or aluminium ore, in the world.¹ The name *bauxite* is derived from the village of Baux in the department of Bouches-du-Rhône, a few miles north-east of Arles, where the deposits were discovered in 1822. (The ores were not exploited industrially till towards the end of the nineteenth century.) Only about 7,000 tons are raised in this area to-day. The main source of the ore used is the valley of the Argens, in the department of Var, in a radius of about fifteen miles from Brignoles, but ores from Bas Languedoc are also used.² Production in 1936 was about 530,000 tons in the department of Var—about one-sixth of the world's production—, about 73,000 in Hérault, and about 6,000 in the Ariège basin in the lower Pyrenees. In 1938, the total production was 684,000 tons and in 1939 it was 709,000 tons. About four tons of red bauxite are needed to produce one ton of aluminium.

Increasing quantities of bauxite are exported abroad, chiefly to the United States and Great Britain. But U.S.A. was importing increasingly from Jugoslavia before 1939.

In the manufacture of aluminium the bauxite must first be treated for the extraction of an oxide of aluminium called 'alumina', which has the form of a white powder. This, in the presence of cryolite, and under the influence of a powerful electric current is converted into the metal aluminium. The production of alumina takes place not very far from the ore-beds, near Marseilles, and conveniently close to the lignite mines of the department of Bouches-du-Rhône. The fact that electrolysis enters, generally speaking, into the process of aluminium smelting, and that a very powerful current is necessary, accounts for the location of the industry in the Alpine valleys, where cheap hydro-electric power is available. Eight out of the dozen French aluminium works are located in the valleys of Savoy: Arne, Isère and Arc. It will be realized that the manufacture of aluminium entails a very great capital outlay, chiefly in the provision of an adequate and reliable supply of electric power, and that being so, companies engaged in the production of aluminium will take care to ensure for themselves a long-period supply of suitable ore. The acquisition of bauxite concessions also involves a heavy capital outlay. These facts are sufficient to account for the relatively small number of plants and the generally high producing capacity of

¹ She has not a monopoly of the European 'bauxite' type of aluminium ore deposits. It is mined in Hungary, Italy, Jugoslavia, Germany, Rumania, Greece and Ireland; but the French ores are of high quality.

² Chap. X, The Mediterranean Region, pp. 316, 317.

the undertakings concerned. Aluminium alloys are increasingly important. Duraluminium is manufactured at Rive de Giers in the department of Loire.

The relative inaccessibility of the Alpine smelting-works entails somewhat heavy transport costs, which drawback is mitigated, however, by the high value, per weight, relatively to iron and steel, of aluminium.) The working up of the metal is not confined to the mountain regions, but is distributed in the various coal-fields and other places. Hyères, for example, and Froges, near Grenoble, manufacture kitchen utensils.

Engineering. This branch of the iron and steel industry employed 1.4 million persons in 1931. Of these, 580,000 were engaged in mechanical engineering, while the electrical branches of the industry employed 150,400. Although the industry as a whole is widely dispersed throughout the country, its various branches show definite geographical influences in their location. Thus heavy mechanical engineering is naturally located with a relation to sources of fuel and raw material and many large firms are found on the coal- and iron-fields, often associated with important iron and steel works, for which they are able to supply equipment. Again, launching and transport facilities are controlling factors in the location of ship-building and marine engineering. The Loire estuary, deepened and improved, has important centres at Nantes and St. Nazaire and small establishments exist at other large ports. The port of Paris with its elaborate canal connexions has works at St. Denis. But ship-building in France is on a relatively small scale. Steam locomotive building is largely a coal- or iron-field industry, and is carried on in the industrial north, but the chief centres are also important railway junctions, for example Lille, Paris, Strasbourg and Graffenstaden, and at Douai and the Valenciennes district, on the Centre coal-field at Le Creusot and the Chiers valley from St. Chamond to Givors, and on the Lorraine iron-field at Nancy and Lunéville. Cheap power plays its part in the works of Bagnères de Bigorre in the Pyrénées and at Givors near Lyons.

Light engineering, being less severely controlled by cost of transport than the heavy branch, is much more widely distributed, plays its part in the industrial life of all large communities and tends to specialize for local markets. Most of the minor coal-fields have developed light engineering works as, for example, the cutlery works at St. Etienne, the railway and mining equipment factories of Clermont-Ferrand, and the engineering works of Montluçon and Commentry.

Other conditions have influenced the location of works using special steels, aluminium and various alloys, where smelting and

working up requires the electric furnace) cheap hydro-electric power has carried such industry into the Alpine valleys, with centres at Grenoble and Lyons. Market control is shown in the activities of the Lille-Roubaix-Tourcoing area in the north and in the Strasbourg-Mulhouse-Belfort area of the east, where engineering specializes in the production of textile and allied machinery and machine tools. Finally, strategic influences have had a hand in the development of the great armament works of the St. Etienne-Le Creusot district. Dispersal of a part of the automobile and aircraft industry, which had concentrated on the outskirts of Paris, took place after 1930 and aircraft production was confined to a central and west-central zone as far removed as practical from the dangerous frontiers of sea and land.

(THE CHEMICAL INDUSTRY. In the chemical industry France has a number of natural advantages, most of them based directly on the mineral wealth of her soil. Among these we may place first her abundant supply of *limestone*.) This has been a great asset to her not only in the production of building stones, of which she has large supplies, but particularly in the production of *cement*, the location of which is related to the areas of Jurassic and Cretaceous rocks. By far the most important development of this industry has taken place in the neighbourhood of Boulogne, where about 60 per cent of the French cement is made. A mixture of 20 to 25 per cent clay is necessary in the fabrication of slow-setting Portland cement, and the establishment of the industry at Boulogne was due in the first instance to the utilization of a natural mixture found in the marls of the coast. St. Quentin is a subsidiary centre of the manufacture. Hydraulic cement is made in large factories at Le Teil in the Rhône valley. Increasingly large quantities are made in the Alpine valleys, especially near Grenoble, and in the Pyrenees. In the Côte d'Or at Pouilly and Dijon large quantities of Portland cement are made. Roquefort in Bouches-du-Rhône and Nîmes are centres for the industry in the Midi. All these establishments are based on the presence of local *limestones* and *bauxite*, from which a very hard, quick-setting cement is manufactured. The production has increased rapidly since 1918 and in 1930 attained over 8,000,000 tons per annum.

The re-acquisition of Alsace made France independent of foreign *potash* supplies, and provided an enormous asset for French agriculture as well as an important article of export. The possession of these potash salt deposits in France deprived Germany of her monopoly of this product. In the hands of the German *Kalisyndikat* the Alsace mines were limited to a production of 4 per cent of the total German output, i.e. about 50,000 tons.

Exploitation in French hands increased the output to 194,000 tons in 1920, to 506,000 tons in 1930, and after a decline to 327,000 tons in 1932, to a peak of 582,000 tons in 1938.

The return of the iron-field of Lorraine with its blast-furnaces to France has meant a great increase in the production of *basic slag*. French production in 1937 reached about 1,250,000 tons, three times the pre-1914 output. About half of this is used in France, and about half is exported, chiefly to Germany.

France has natural *phosphate* deposits in Boulonnais and in the eastern edge of the Paris basin, which are used directly in agriculture ; but in addition she controls very valuable deposits in the neighbourhood of Tunis and in Algeria and Morocco, which produced 3.9 million tons in 1937. This is mainly converted into superphosphates, of which France now produces more than any other country in Europe—about 1.2 million tons. Conversion takes place mainly at the ports in order to save transport costs, and to facilitate the export of the large surplus.

(For the production of *sulphuric acid*, which is an essential element in a very large proportion of chemical processes and particularly in the fabrication of superphosphates and soda, France is also well situated, for she not only produces iron pyrites in her Pyrenean departments, but she is in a position to import easily, via her Mediterranean ports and Bordeaux, pyrites from her North African departments and from Spain. She manufactured in 1936 about one-thirteenth of the world's supply of sulphuric acid ; before 1914, she was fourth world producer, by 1928 she held second place after the United States, but by 1938 she was also surpassed by Japan, Germany and the U.S.S.R.

(For the basic raw material of a large number of important industries in which *soda* is used, such as the textile, glass, soap and paper-making industries, France is again well supplied.) In addition to the deposits of rock-salt and brine-pits in the Liassic marls in the neighbourhood of Nancy at Dombasle, she utilizes the lagoon salt obtained by evaporation on the shores of the Mediterranean. Added to this she has now the brine-field of Château Salins and Dieuse in the Seille basin of Lorraine in the department of Moselle.

(The development of hydro-electric power in the Alps and Pyrenees has benefited France as regards the development of her chemical industry.) It is enabling her to manufacture calcium carbide, and from it calcium cyanamide, an important nitrate fertilizer. Ammonia is obtained from the cyanamide by treatment with water. At the old powder-works of Toulouse, great installations based on power from the Garonne have been set up

during and since the war of 1914-18, in which the Haber-Bosch and other processes of making synthetic ammonia are used.

There has been a very great increase since 1919 in by-products from the coke-ovens and retorts. Thus while 8.96 million tons of coke were produced in 1936, by-products included 474,000 tons of tar, 104,000 tons of ammonium sulphate and 88,000 tons of benzol. There was also a wide range of further distillation products—naphtha, creosote, naphthalene, aniline (and a resultant variety of dyestuffs), and perfumes. The formation of an international cartel with Germany and Switzerland points to a serious inroad by the French industry into the markets of these countries.

France is fortunate again in her possession of the great forests of the Landes, which supply her with the resin for the manufacture of the paints, lacquers, and varnishes for which there is now so great a demand.

We see, then, that apart from her deficiency in coal, France is, particularly since 1918, exceedingly well equipped as regards the raw materials required for the chemical industry, and that she has not been slow to utilize her advantageous position.

TEXTILES. The textile industry is much more widely spread even than the iron and steel industry, but there are four areas of concentration focused in Lille, Rouen, Mulhouse and Lyons. The industry employed 920,000 people (at the last occupational Census of 1931), whose traditional skill is a dominant factor in its distribution. In France it went through the normal phases of development from the farm industry based on home-grown flax, wool and hemp.

The woollen industry was at first as widely distributed as the rearing of sheep, but concentrated later in Flanders, where, having outgrown local supplies, it depended on wool imported from England. On this industry grew up the flourishing centres of the Flanders plain, whose rich buildings and great cloth halls bore witness to its prosperity. The active development of cloth-making in England was a severe blow to this prosperity, though the flax industry increased and flourished. With the introduction of steam-power the woollen industry was revived and concentrated in the Roubaix-Tourcoing-Fourmies district close to the Belgian frontier. Wool-combing became a specialized line. Before 1914, raw wool was imported in increasing quantities from London and direct from Argentina to Le Havre and Dunkirk, and combed wool was exported to Germany, Belgium, Italy, Switzerland and to Austria. France lost the whole of her wool-combing plant in the devastation and pillaging of the northern departments.

She has since reconstructed the industry on modern lines and has made great strides in the manufacture of light cloths.)

The revival of the woollen industry at Elbœuf, on the lower Seine, was a direct result of the invasion of the Nord.

An interesting side of the woollen industry has developed on the western flanks of the Central Massif around Mazamet and Castres, in the department of Tarn. Mazamet is the centre of the fellmongering industry, and imports sheepskins from Australia, South Africa, and Argentina, cleans and dresses the pelts, and utilizes the fleece taken from them for carding. Wool pulled from the pelt in this way has a long staple, and is much in request for the making of light, soft fabrics. Latterly wool-combing has been introduced. The district specializes in knitted goods and hosiery, but also makes cloths, particularly flannel. Once again adaptability and variety in French industry has enabled France to meet competition, and she now excels in the production of fancy woollen materials to supply the demands of the constantly-changing fashions in women's clothes. In 1913 France exported 18,300 tons of woollen cloth; this amount increased to 29,820 tons in 1938.

The survival of the woollen industries of Reims and Sedan is an example of geographical inertia aided by good railway communications.

Flax, at one time a very important crop in Flanders, still remains a characteristic crop of the Scarpe and Lys valleys, where the abundant streams make flax-retting easy.) To-day the manufacture of linen holds an important place in the north industrial region, which produces about 85 per cent of the whole. Armentières, La Bassée, Lille, Halluin, Valenciennes and Caudry are the chief centres of the weaving manufacture, which includes to-day the use of jute, hemp and cotton as well. The goods manufactured vary from the coarsest sail-cloth to the finest damasks and cambrics. (The making of linen thread developed very early in the Lys basin. The spinning of flax is concentrated in the neighbourhood of Lille.)

(When *cotton* appeared on the scene, linen had to make way for a powerful rival. The industry took root in the small woollen centres in and around Rouen, because local skill acquired in the woollen industry, cheaply transported raw material, and coal were available, with clear water from the rapid streams that descend from the plateau of Caux. The Flanders towns were quick to adapt themselves to the demands for the new fabric. They were enabled to do so readily because of their excellent communications and because of the coal-mines.) Proximity to the coast has been an advantage in the export of yarns and

fabrics. Spinning is concentrated in the Lille and Roubaix-Tourcoing districts. Weaving is scattered throughout the region. Hosiery manufacture is centred at Roubaix.

Rouen, where contact with the Atlantic coast and America by the Seine valley and Le Havre gave an advantage as far as the acquisition of the raw material was concerned, and where seaborne coal could be delivered by water, was able to hold its own in the competition with the Nord and Vosges districts, though the former had the advantage of being situated on the edge of the coal-field; but being mainly a spinning district, it was suffering even in 1914 from an over-production of yarn. During 1914-18 it was able to supply the urgent demands for cloth made as a result of the temporary extinction of the Flanders industry and the paralysing of the Vosges mills.

In the Vosges the cotton industry was introduced in the middle of the eighteenth century through the establishment of calico and muslin printing-works, and calico printing has continued to be an important branch of the industry in this region. Then the spinning of cotton was introduced as a cottage industry in the Vosges valleys and spread rapidly through all the valleys of Upper Alsace. Steam-power installed in the mills of the plain entailed a concentration of the industry in and around the towns of Mulhouse and Colmar, and drained much of the labour from the valleys, but did not destroy the upland industry. The Franco-Prussian War resulted in driving a section of the industry across the Vosges to the western valleys, where it grew and prospered around the centres of Epinal and Belfort. This was facilitated by the construction of railways and the Canal de l'Est, and by the imposition of duties which freed the nascent industry from competition from the other side of the Vosges. Spinning developed rapidly, for in France the weaving industry was, for some time, ahead of the spinning, and Swiss and English yarns had to be imported. Finishing works and calico printing followed the spinning and weaving, so that to-day a cotton industry, complete in all its branches, is established in the Vosges. Twenty thousand spindles and 9,000 looms were destroyed in the war of 1914-18, but the mills are for the most part at work again and are employing about 50,000 workmen.

The return of Alsace in 1919 brought to France an increase of about 25 per cent in spinning capacity, increased the number of looms by 33 per cent and the calico printing plant by 50 per cent. Before the war of 1914-18, Germany had been the chief market for Alsatian cotton goods. That market being, to a large extent, closed now, France has been fostering with considerable success a market for her surplus cotton goods in her colonial areas, which

are included within in her customs frontiers. American, Egyptian and Indian cotton are used, but there is a tendency towards the use of the coarser counts as the colonial market increases. A great variety of goods is made, including a large number of fancy fabrics such as *crêpes* and *organdis*. The spinning done is mainly for local mills. The re-acquisition of Alsace has been felt somewhat disadvantageously, however, as adding a highly-organized and well-equipped competitor in the home market.

Smaller cotton industries are centred at Amiens and St. Quentin in Picardy, where a variety of mixed fabrics is made; at Troyes, which is the chief centre of cotton knitting and hosiery fabrication; and at Roanne. Roanne is connected with St. Etienne and with Thizy, Amplepuis and Tarare, and comes into the Lyons group of textile sub-regions. Cotton is only one of the textiles that occupy the mills of the district.

There is a large number of small cotton industries scattered up and down the country, chiefly carried on in cottages and small workshops. Knitting (hosiery) and lace-making account for most of these. The lace-making industry of Calais has several large mills, but employs some 500 people in small workshops as well.

As a result of the war of 1914-18 the cotton industry had to be built up again from the start. To-day it is suffering much from the competition of artificial silk, and the import of finer grades of cotton has fallen off greatly. The United States furnished 75 per cent to 80 per cent of the cotton consumed in France before 1914, Egypt and India coming next. The average import from America is only a little more than 50 per cent, and the proportion of Indian and the coarser type of Egyptian cotton is increasing.¹

The French cotton industry, particularly since the reconstruction enforced by the war of 1914-18, has shown a tendency to concentrate on large-scale production of standardized goods like the concentrated industries of Germany and Great Britain, especially in the north. The smaller and more scattered establishments are feeling the competition keenly. Will this mean a falling off in the more specialized fabrics in which she has made a name?

SILK. Side by side with the development of the linen, cotton and woollen industries, we have that of sericulture, silk-reeling and weaving. Sericulture was introduced from Italy in the fifteenth century. The rearing of silkworms and the reeling of silk from the cocoons developed as a cottage industry accessory to agriculture, forming a side-line occupation for the peasants'

¹ In 1938 France imported 277,000 tons of raw cotton, of which 143,000 came from the U.S.A., 43,000 from Egypt and 38,000 from India.

wives and daughters.) Silkworm disease and the competition of Japanese and Chinese silk gave a serious blow to this side of the industry, for the work of rearing the worms is arduous, and the industry was all the more exacting in that it demanded that a whole room should be set aside for the rearing of the worms. The pre-1914 production of cocoons was only 2 per cent of the world production, and the amount of cocoons produced has been halved since 1913, partly owing to lack of cultivators and partly to lack of mulberry leaves.¹ Raw silk is imported for the industry mainly from Piedmont, Syria and Shanghai.

The valleys of the Alps and Central Massif provided both raw material and, what is more important, a constant stream of cheap labour to the centres of the coal-fields (St. Etienne) and of the Rhône plain. Power is forthcoming from the small local coal-fields in the form of steam and thermal electricity, and hydro-electric power is supplied by the Alpine rivers and, to a small extent, by those of the Central Massif.

Silk is the most valuable export product of France, two-thirds of the silk produced on an average being exported. It is in this department of her textile industry that France exhibits most successfully her genius for individuality in production and for co-operation in organization. The close collaboration of the directors of the various branches of the industry—spinning, weaving, dyeing, printing and finishing (which last includes a multitude of skilled operations) has played a vital part in the success of the Lyons products in the world market.

RAYON. France was one of the three pioneer countries to develop the rayon industry. The industry was started in the early nineties in France, at Besançon. The estimated French output of rayon in 1938 was 28,000 tons, and the country ranked as the sixth world-producer. Output was sufficient to cover internal requirements. There are two chief processes, the viscose and the cellulose-acetate processes.

Between 80 per cent and 85 per cent of the rayon produced is of the viscose variety. The raw materials are ligno-cellulose or wood pulp, and cotton linters. As the industry is closely related to the chemical industry, it does not usually attach itself to a recognized textile area. In fact, in flourishing textile areas the absence of surplus labour has made it impossible to introduce the rayon industry. (The main controlling factors in the location of the industry are access to supplies of coal, the presence of female labour and ample water supply.) Large quantities of soft water are required, and if the water available is hard, then artificial softening has to be resorted to, and the geographical factor expresses itself

¹ *Revue d'Economie Politique*, May-June, 1929.

in this case in the cost of production and not in location of the industry. France also produces about 600 tons per annum of acetate of cellulose.

Rayon is manufactured at St. Chamond, Izieux, in the Lyons-St. Etienne region, and in a number of other areas in France—at Strasbourg, Besançon and Colmar in eastern France, at Moy, Givet, St. Quentin, Valenciennes and Calais in the north, and at Arques, St. Aubin and Argenteuil in the Seine basin. Apart from the production of rayon fabrics the thread is used in the cotton, woollen, jute and silk industries in the fashioning of mixed fabrics.

CHAPTER XIV

COMMUNICATIONS

RAILWAYS

FRANCE had, in 1936, 56,000 miles (90,500 km.) of railway track and 27,000 miles (44,000 km.) of railway routes. The railway density is considerable, being 11.4 km. per 100 sq. km. of country.¹ These figures refer only to the main-line network, known as '*d'intérêt général*'; there are also about 12,500 miles (about 20,000 km.) of light railways and tramways classified as '*d'intérêt locale*.'

Largely on account of its natural nodality, Paris has become the main terminus of almost all the French railway systems, just as London has for the British. This arrangement has its disadvantages, for it has meant serious congestion in the Paris complex of lines and enforced detours for transit traffic from port to port.² There are great geographical difficulties to be overcome, however, in creating direct east to west routes avoiding Paris, because of the serious barrier to transport imposed by the crossing of the Central Massif, although through transport is now provided between the Atlantic ports and the Rhône valley. Difficulties also exist in creating through transport between the Channel ports and the Rhine and Rhône valleys, though great efforts have been made to establish through services from Dunkirk for both passengers and goods.

There has been a movement towards the electrification of railways in the south. This, however, can only be slow, on account of the limited supplies of coal in the south and the limited capacity of the French rivers for supplying hydro-electric power. By 1939, just over 2,000 miles of main lines had been electrified.

Before 1937, the railways of France consisted of four private systems—*Nord*, *Est*, *Paris-Lyon Méditerranée*, and *Paris-Orléans-Midi*; two state-operated systems, *Etat* and *Alsace-Lorraine*; and the two Paris belt-lines—the *Petite* and *Grande Ceinture*. In 1937, largely as a result of the very serious adverse financial position of the various companies, nationalization of the French railways

¹ cf. a density of 33 in Belgium, 13 in Great Britain, and 12 in Germany.

² The Grande Ceinture Railway, which carries goods traffic round Paris, facilitates the traffic between the northern and southern lines.

Maubeuge. Creil is thus a very important junction, for through it pass trains from Berlin, Brussels and Amsterdam, as well as express trains from the Channel ports.

Of this company's lines, totalling 2,359 miles¹ (3,796 km.) only 18 per cent is on the level and 480 miles have a gradient of between 1/200 and 1/100. No portion, however, has a gradient of more than 1/40, for the most serious obstacles to be traversed

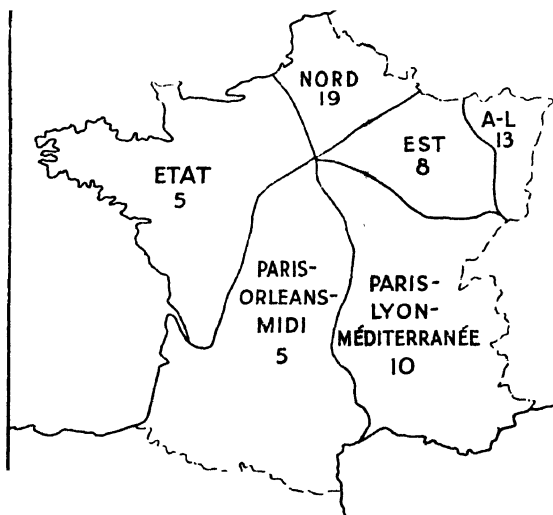


FIG. 93. THE AREAS SERVED BY THE FRENCH RAILWAY COMPANIES BEFORE THE FORMATION OF THE S.N.C.F. IN 1937. THE FIGURES REFER TO THE TONNAGE OF COAL AND COKE CARRIED ON EACH SYSTEM (IN MILLIONS)

are the Boulonnais and the Sill of Artois. The line from Calais to Boulogne has to negotiate the crossing of the Haut Boulonnais near its highest point. The gradients are steep and there are long tunnels. It then follows the gradient of the Somme valley to climb to the plateau top at Amiens, whence it cuts across the plateau to Paris, crossing the Oise at Creil. The lines from Ghent and Brussels converge at Douai to pass up the Scarpe valley to Arras, where they are joined by a line from Dunkirk via Hazebrouck, which crosses the coal-field between Béthune and Lens. From Arras the Sill of Artois is utilized to cross the chalk ridges into the Somme valley. There is a fairly steep gradient to the bottom of the Ancre valley which the line then follows via Albert to Amiens. The plateau of Beauvais is crossed by utilizing tributary valleys of the Somme and Oise ; but there are one or two awkward ridges to be crossed between Creil and Paris, in

¹ Normal gauge.

which a long tunnel and steep cuttings play an important part. The lines of the Nord company are all run on steam-power. This is one of the most important *réseaux* in France, having the largest total tonnage of all the French lines,¹ coming third in the density of goods traffic² and second to the *Etat* system in respect of the number of passengers carried; for it not only serves the ports of the Straits of Dover, but is intimately linked with the great European highways that converge in the neighbourhood of the Rhine mouths. The bulk of the goods carried (over 40 per cent in 1936) was coal, which is to be expected, since the network of lines which ramifies through the coal-field belongs, with the exception of the Somain-Anzin line (twenty-three miles long), to this system. No other system in France dealt with so large a quantity of coal.³ Metallurgical coal and coke enter France from and by way of Belgium, and much coal from the French mines passes in the direction of Paris. Other noteworthy articles of transport are building stone, chiefly from the Ardennes, and cereals.

The *Chemin de Fer de l'Est* serves the greater part of Lorraine the eastern section of the Paris basin. There are two main routes, one from Paris to Nancy via Châlons and Vitry and the other from Paris to Belfort via Troyes. These are continued to the Rhine at Strasbourg and Basle by the Alsace-Lorraine State company's lines. The total length of route is 3,100 miles (4,988 km.), of which 24.6 per cent is on the level. This is interesting when we consider that this system of railways traverses the high plains and *côtes* of Lorraine and crosses at right angles all the escarpments of the Paris basin. It emphasizes the economic importance of certain geographical features to which we have already drawn the reader's attention: the valleys trenching the high plains as they converge upon Paris and opening gaps in almost direct line with the gaps of Toul and Belfort. This system of lines is run entirely on steam. In total goods traffic it came second to the Nord, and it was so also in the density of traffic. The most important item, carried by weight, was ores, in which it came easily first.⁴ The second item was coal and coke, in which its position was only fourth.⁵ The third item in importance was iron and steel. The amount of cereals carried is relatively small, for the industrial population is nothing like so dense here

¹ *Statistique des Chemins de Fer Français*, 1938. All tonnage figures given are for goods carried by *petite vitesse*. Express trains (*grande vitesse*) carry only perishable food-stuffs, livestock and postal packets, amounting in no case to more than 1,500,000 tons.

² Density of traffic is reckoned in ton-kilometres per kilometre of line.

³ Nearly 20 million tons were carried on the Nord system in 1936.

⁴ In 1936 it amounted to 13.4 million metric tons.

⁵ 7.6 million tons in 1936.

as it is in the Nord, and Lorraine itself produces large quantities of grain. Large quantities of building stone are carried on these lines too, limestones, cement and sandstones forming the bulk of goods under this heading. The Nancy line to Paris takes advantage of the gap that the Moselle has carved completely through the limestone *côtes*, then follows the Toul gap,¹ utilizing the former valley of the Meurthe, but tunnelling through a spur to avoid a sharp bend in the valley. It threads its way across the Côtes de Meuse, using natural gaps cut by tributary streams, crosses the Portland limestone ridge at Bar-le-Duc, strikes the Marne valley at Vitry-le-François and follows it to Paris, crossing the Tertiary escarpment by the Epernay gap. The line from Belfort uses the high-level route through the Belfort gap, traverses the plain of the Saône in Franche-Comté, approaches the Burgundian escarpment diagonally through the valleys of Bassigny,² and tunnels through the two limestone escarpments that protect Langres. Having crossed the divide it descends the rim of the Paris basin, which it traverses by means of the Marne, Aube and Seine valleys successively, utilizing the clay vales in order to pass from one valley to another, and passing through the series of escarpments by the river gaps. It follows the transverse and longitudinal course of the Seine to Nogent, where it leaves the river to take a more direct course across the Tertiary plateau to Paris. Passengers from London by the Swiss-Arlberg-Vienna express join this route at Châlons-sur-Marne, thus avoiding Paris.

The *Alsace-Lorraine* system, which links the lines of the *Est* to the Rhine plain, has only 1,299 miles (2,090 km.) of route, but is extremely important, particularly for passenger traffic,³ for two of the three great trans-continental lines from western Europe to Vienna via Strasbourg and/or Basle use this system. Branching from the trunk line Strasbourg-Mulhouse, a number of short lines serve the *Vosges* valleys. None of them, until the opening of the St. Dié-Epinal line in 1929, crossed the *Vosges*. For strategic reasons mainly they stopped short of the frontier, as did those of the *Est* on the Lorraine side. The new linking section shortens the route from Strasbourg to Epinal by about eighteen miles. None of these lines is so far electrified. The percentage of line on the level is 23.4, fairly high, by reason of the long stretch of line that follows the Rhine plain. This system came fourth in the total tonnage of merchandise carried (about 38 million tons), but the traffic was denser than on any other French system, for there was much through traffic to Basle, as

¹ p. 346.

² See *The Paris Basin*, Chap. IV, p. 113.

³ Over 73,000,000 passengers in 1928.

well as the traffic concentrating on Strasbourg and Mulhouse. The largest item in the list of merchandise carried was coal and coke. It came second to the *Nord* in the transport of these commodities (12.5 million tons in 1936). It came second to the *Est* in the transport of ores, with about 11.5 million tons, thus reflecting the gradual resumption of the pre-1914 interchange of coal and iron with the Ruhr district.

The *Paris-Lyon-Méditerranée* line has the longest mileage of any of the French systems, 6,182 miles (9,949 km.) normal gauge. Its main line is that from Paris via Lyons to Marseilles, running from Paris via Joigny and Nuits-sous-Ravières to Dijon, which has the busiest station in France. The Saône-Rhône valley line passes to Lyons, Marseilles, Toulon and the Riviera, and the line to Milan and Trieste via Lausanne and Brigue (the Simplon express route) crosses the Jura to Vallorbe by the Mont d'Or tunnel, three and three-quarter miles long, mainly in French territory. This base tunnel was finished in 1913. Before that the route went round via Pontarlier on the route to Berne—a much longer route with difficult gradients, a large number of tunnels and viaducts, and a summit of 3,000 feet. The Lyons-Marseilles line is doubled by a line which follows the right bank of the Rhône and connects Lyons with the agricultural region of Bas Languedoc and south-west France. Special trains are run on this line to carry *primeurs* to Lyons, Paris and the north. A secondary route branches from the main trunk line at Moret, where the Loing joins the Seine, about six miles above Fontainebleau, and follows the industrial Loing valley southward via Nemours to Montargis, cuts across the Sologne to the Loire at Gien, whose right bank it follows through Sancerrois, traverses the metallurgical district of Nivernais, crosses the Loire at Nevers, and then follows the Allier valley, keeping to the western edge of the Sologne Bourbonnaise and of the Limagne till it reaches Clermont-Ferrand. Here, within the Central Massif, it is still only about 1,000 feet above sea-level. Above Clermont it climbs from basin to basin in the Loire valley, crosses the Cévennes at La Bastide, whence it wriggles and bores its way down the escarpment to Alès and through the limestone foot-hills to Nîmes, and so to the Rhône crossing at Beaucaire-Tarascon, where it joins the Rhône valley line. (A loop line from Moulins passes up the Allier valley, serving the basins of Roanne, Le Forez and Le Puy.) It is the only line that crosses the Cévennes, though a minor line, crossing the Cantal, traverses the southern Causses and Escandorgue and descends to Bas Languedoc. A number of lines join these basins of the Massif with the Rhône valley line, utilizing the north-east to south-west valleys that furrow the eastern edge of the Massif.

Of these the most important for local traffic is that connecting Lyons with St. Etienne. Another branch serves the Charolais district, and a third the Roanne industrial region. Obviously the highland sections of these lines cannot pay, except in the industrial areas of the eastern Massif. They have been exceedingly costly to construct owing to the large number of deep valleys that have to be bridged and to the hardness of the rock that has had to be cut for tunnels and cuttings. Running costs are high in the Cévennes because of steep gradients and the small number of passengers. In the winter much trouble is encountered from snow, so that certain sections of the line are protected by wooden sheds.

The P.L.M. also serves Franche-Comté and Bresse with lines running to Besançon and Belfort. From Lyons, the more southerly focusing point of the system, starts the important line which branches at Culoz to Geneva and, via Aix-les-Bains and Chambéry, to Genoa, Rome and Naples, this branch joining the Italian system at the Mont Cenis tunnel on the frontier. Since 1927 there has been an express service between Switzerland and the Mediterranean via Chambéry and Grenoble. One of the few west to east routes in France that avoids Paris traverses the Central Massif from Bordeaux via Gannat to Lyons, to join the Milan and Orient Express route. Via Nevers, Bourges and Tours, Lyons links Nantes, St. Nazaire and La Rochelle with central Europe and Marseilles. There are some very steep gradients on this system, as one can well imagine, seeing that it serves parts of the Alps, the Jura and the Central Massif. The percentage of level track is smallest, with the exception of the Nord system, and would of course be very low indeed but for the long, level stretches of the Rhône-Saône corridor. There are 90 miles in which the gradient is over 1/40 and 1,490 in which it is between 1/40 and 1/100. Sixteen miles of the P.L.M. system are electrified. This line came third in the total tonnage of goods carried, with about 38 million tons, slightly more than the A.L. system. In density of goods traffic by weight it was also fourth. Coal and coke accounted for the largest item of tonnage on the P.L.M. system (about 10 million tons); building stone is important—marble and limestone and volcanic stone from Volvic, etc. These lines are a long way ahead of the other systems in the transport of wines (2.4 million tons), for they tap the Midi, Burgundy and the Jura vine districts. In the transport of goods by express, only the State lines are more important. Over half a million tons of goods, largely perishable commodities, such as *primeurs*, flowers, fruit, milk and fresh fish, are carried by express, often in special refrigerator or insulated wagons.

In the other direction there is an important traffic in goods from north-west Europe, via Lyons and Marseilles, for Eastern Europe, the Levant and the Far East. Some 2·1 million animals, nearly double the number moved by any other company, were carried on the P.L.M. This is accounted for by the modern expedited methods of *transhumance* of sheep and cattle.¹

The Paris-Lyon-Méditerranée lines, then, not only provide a rapid service for the distribution of local products, but with Lyons as a great 'carrefour' they supply links in some of the most important European trunk lines.

The *Chemin de Fer de l'Etat* owns the second largest individual railway net in France, with a total mileage of 5,953 (9,581 km.), of which thirty-five miles are electrified. It serves the whole of north-western France, in the triangle Dieppe-Paris-Bordeaux, with the exception of the line from Tours to Brest via Nantes, provided by the Orléans Company. It has the largest amount of level track in France (26·6 per cent), but there are twenty-one miles of track with a gradient of over 1/40, owing to the deeply trenched valleys of the Paris basin and Brittany. It is interesting to note how the long tidal *rias* of Brittany force the main lines of railway to avoid the coast. This system carries more passengers than any other line, 176,000 in 1936, for it provides boat-trains for the ports of Dieppe, Le Havre, Cherbourg and Brest, and in addition caters for much of the Paris suburban traffic. The network of local lines of one-metre gauge is very close throughout the system, and there is a marked convergence of lines from the lower Loire and Bay of Granville towards Reenes. The gaps in the railway system are now being filled by public omnibus services. The total tonnage of goods carried was not very great (29·6 million tons), the density of goods transport being the lowest of the six great systems; for, apart from the lower Seine and Loire districts, which receive their coal mainly by water, no large manufacturing district is tapped. The heaviest tonnage, as usual, is coal, 5·3 million tons railed from the ports to the interior, after which comes building stone. Large quantities of perishable food-stuffs are sent by these lines to Paris and to the Channel ports for export, and fresh fish and chilled and frozen meat are carried from the ports to Paris and other markets. Sheep and cattle are transported in large numbers to the Paris *abattoirs*. A large number of postal packets are carried to Paris and the ports. An interesting feature of the State system is the doubling of the Orléans route from Tours to Bordeaux by a line which crosses the Loire at Saumur and passes through no town of any significance between Chartres and the Garonne.

¹ See *Transhumance*, p. 402.

¹*The Paris-Orléans* system has a mileage of 4,591 (7,393 km.). Of these lines 25·5 per cent run on the level, but there are 37 miles with a gradient of over 1/40, there are also 1,620 miles with a gradient between 1/40 and 1/100. This high percentage of steep gradients is mainly due to the Paris-Tours-Bordeaux line via Poitiers and Angoulême, which carries the *Sud-Express*—five express trains in twenty-four hours—and to the highly accidented route across the plateau from Orléans to Toulouse via Limoges, which crosses all the deep valleys draining the western slopes of the Central Massif. It serves the three little coal-fields of Brive, Aubin (Decazeville) and Albi, and sends branch lines to Montauban via Cahors.

The Midi system has 2,680 miles (4,313 km.) of normal-gauge lines; 24·5 per cent is run on the level, yet there are over eighty miles of line with a gradient of over 1/40. These are mainly in the Pyrenees, and it is here that electrification of railways has made most progress in France. The trans-Pyrenean railways are from Pau via the Somport to Jaca in Spain in the west, and from Toulouse via Ax-les-Thermes and Puigcerda to the Ribas valley and Barcelona in the east. The coast railway in the west from Bayonne via Hendaye-Irun encounters no serious difficulties of relief, but the line that skirts the eastern extremity of the Pyrenees is a *corniche* railway, as it rounds the end of the Cap Cerbère, and has to cross the Albères ridge to reach the plain of Ampurdan. The mountain railways carry very few passengers at present, most of the international transport passing round the ends of the Pyrenees. The two main lines run from Bordeaux, the one skirting the edge of the Landes to reach the Spanish frontier and join the lines to Madrid and Portugal, the line of the *Sud-Express*, and the other following the Garonne to Toulouse and then passing via Castelnau-dary into the Aude basin, over the Sill of Lauraguais and through the Gate of Carcassonne, whence one branch goes to Narbonne and Perpignan and the other serves Bas Languedoc.

¹The merged P.O.-Midi system had, in 1936, 1,757 miles (2,828 km.) of electrified route, supplied with current from the hydro-electric stations in the Pyrenees and in the Central Massif, and also during periods of low-water from the Gennevilliers thermal station.

The combined freight traffic in 1936 totalled only 27·7 million tons, the lowest of any system, in spite of the fact that the total mileage considerably exceeded that of any other. This is mainly due to the paucity of industrial centres. The chief items of freight comprised coal (5 million tons in 1936), wine and animals (about 1½ millions, chiefly sheep and goats).

¹ Note.—The Paris-Orléans and the Midi systems were merged in 1933.

INLAND WATERWAYS

Besides the 27,000 miles of railway, France had 6,019 miles (9,688 km.) of canals and navigable rivers in 1937.

Before we describe the waterways of France, it may be as well to summarize the geographical conditions that control the utilization of waterways for transport. A consideration of the relief map (Fig. 1) enables us to rule out at once as unnavigable without artificial regulation all the streams in the Alps and Provence on the grounds of gradient. The map showing annual rainfall (Fig. 3) suggests that only a very small proportion of French rivers are rendered unnavigable by lack of rainfall in the catchment area; on the other hand, an examination of a simplified geological map makes it clear that the navigability of certain rivers must suffer from a great irregularity of flow by reason of the nature of the rocks that constitute the gathering grounds of their water-supply. The impermeable rocks throw off the rainfall rapidly where there is sufficient gradient. Such areas stream with water during rainy periods, but, lacking natural reservoirs, tend to dry up in periods of drought, and normally during the dry-weather season their contribution to the rivers diminishes in a marked degree. When, on the contrary, heavy rainfall is experienced in such catchment areas, the water reaches the valleys with astonishing rapidity and the flow of the streams becomes torrential. The permeable rocks, on the other hand, allow the water to escape underground, and the run-off is relatively small. In the limestones of the Jurassic and Triassic systems the escape of water underground by fissures sometimes reaches great dimensions owing to the solution of the limestone, as in the Jura. The underground movement of the water is very irregular in these formations. In the chalk limestone of the Cretaceous rocks we find that the subterranean water tends to form a continuous body, filling the interstices of the rock as it might a sponge and forming a more or less continuous subterranean surface or 'water table'. In areas where such permeable rocks predominate, the water precipitated reaches the watercourse gradually, and its flow is regulated as though by passing through a cistern. It emerges in the valley-bottoms, or on the slopes, or along the edges of escarpments at levels varying with the position of the floor of the permeable rock layers and with the level of the water table. Surface erosion is naturally relatively slight under such conditions, and the rivers develop but few tributaries.¹

River régime is also affected by natural or artificial surface storage within the catchment area. Such storage is constituted

¹ See Fig. 22.

by lakes and reservoirs or by snow-fields and glaciers. The latter types of storage are obviously not very satisfactory, for they cannot be controlled in any way and the water is only periodically available.

It is obvious that rivers will differ greatly from one another in régime, and that the régime of any one river will vary in different parts of its course, according as it may be affected by factors of climate, relief, rock and soil permeability, and storage capacity. These factors of a physical nature have already been dealt with in some detail in the individual studies of the major river basins, and we shall now only make reference to them where necessary for the elucidation of our discussion.

France has no great navigable rivers apart from the Rhine, and it is only in northern France that there are streams with a sufficient depth and regularity of flow to be naturally navigable. Yet, although the mountainous nature of the south precludes the utilization of the rivers for navigation, the areas of greatest economic activity are relatively easily linked together by canal, and the natural passage-ways by which the Paris basin communicates with the rest of France—the Sill of Artois, the Gate of Poitou, the Sill of Langres, the Toul Gap—are all crossed by waterways as well as by roads and railways. The lowness of the divide that separates the drainage of the Seine from that of the Loire facilitates water communication between the two river basins.

The Paris basin is peculiarly favoured in its river system, for relief and climate, rock structure and soil combine to ensure a sufficiency and a reasonable regularity of flow in the streams which converge on Paris and are gathered up and carried to the great tidal estuary by the lower Seine. The succession of limestone plateaux, through which the rivers cut, act as water storage grounds and regulators of supply, and the widespread fan of tributaries makes for evenness of flow in the lower Seine, for it is probable that not all the tributaries will be in flood or deficient in supply at the same time.

When, however, heavy rains are experienced in the whole basin at once, or when melting snows in the Morvan are accompanied by great downpours in other parts of the basin, then the convergence of the streams in the neighbourhood of Paris has its disadvantages and even dangers.

The Loire, for a great part of its course, has a fairly well graded valley. The main cause of its comparative uselessness from the point of view of navigation is the absolute unreliability of the navigable channel. The impermeable nature of the gathering-grounds of the Central Massif tributaries, causing a

rapid run-off in times of heavy rain or melting snow (roughly November to April), and a deficit in supply during the dry period of late summer and early autumn, are the chief causes of this unreliability. In the early spring the waters are out wherever the embankments allow them to spread. In the late summer the river-bed appears to contain little else but vast expanses of sand. It may cover a width of only fifty yards between the sand-banks, but the flood-plain may reach a width of three and a half miles.

The shifting nature of the bed of the Loire has always constituted a great difficulty and danger to navigation. The terraces of loose Quaternary material which line the basins of the upper river are readily eroded when the river is high, and masses of sand are brought down to the middle course and deposited when the stream abates and can no longer carry their weight. Banks of this type appear to be constantly forming and as constantly disintegrating, to be built up again farther downstream. The mobility of the bed of the river has been a serious obstacle to regularization, and certain regulation works, carried out by the State since 1918 on the lower section between Montjean and Nantes, give but little promise of justifying further extension. The Loire has a steeper gradient than the Seine, and, indeed, than any other important French river except the Rhine and Rhône. The gradient is still one foot per mile at the confluence of the Maine, as compared with 0.38 feet per mile on the Seine between Paris and the sea.¹

The Pyrenean and Alpine torrents have gradients too steep and catchments too irregular to afford the even and continuous flow and the freedom from silt essential for economic navigation in the main streams that they supply. These characteristics have been sufficiently illustrated in our account of the régime of the Rhône in Chapter IX.

The Garonne in the basin of Aquitaine resembles the Loire to a great extent as regards régime, though the differences between high and low water are not so great. There are compensating factors due to the climatic differences in the Pyrenean and the Central Massif sources of the tributaries.

On account of the relative speed, flexibility in transport, and the relatively low cost of construction, railways are a much more sound economic investment, generally speaking, than waterways. There are, however, certain exceptions which are well illustrated in France. Where there exists a deep, slow-flowing river or artificial waterway close to an important mining and/or industrial area and communicating directly with markets for the heavier materials brought to or taken from such an area,

¹ Amédée d'Andigné: *Essai sur la Loire navigable*, 1928, p. 123.

or, better still, if the waterway links two or more areas that have large quantities of heavy or bulky goods to exchange, then water transport may be more profitable than rail or road transport. Our study of the Rhine traffic in relation to Alsace, Lorraine and Westphalia has shown us that a waterway under such conditions may play a major rôle in transport.¹ Even so, we have seen that traffic on such a waterway may be hampered for a more or less prolonged period, or altogether interrupted. It is obvious that a means of transport that is dependent on climatic conditions cannot have the same value as a railway system that is normally unaffected by frost, drought and flood. Nevertheless, in a region of low relief, as our study of French Flanders has shown, where climate is temperate and rainfall adequate, waterways may be a very important adjunct to railways, acting as feeders to them and relieving them of heavy freight over those sections of transport routes where goods can be carried without much break of bulk.

Owing to the limitations imposed upon waterway development by relief, water-supply, and other natural conditions, it is clear that there must be considerable areas where waterways cannot compete with railways, and for this reason alone we shall not be surprised to find that the tonnage carried on the waterways of France in 1936 was only 47,800,000 tons as against 364,191,000 tons carried on the railways. The carriage of goods by water relatively to the amount carried by rail has tended to increase, in spite of the fact that the waterways are heavily subsidized, although indirectly so.¹

Navigable waterways in France are officially defined by the requirements of the Freycinet Act of 1879 thus :

Minimum depth 6 feet 6 inches.

Length of locks 126 „

Width 17 „

Air space below bridges 12 „ above normal low water.²

These regulations were drawn up so as to allow for the passage of the 300-ton Flemish *péniche* with a draught of six feet.)

There is, however, a number of waterways that can be and are used to a minor extent, but whose dimensions do not come up to the above requirements. There is a third category of streams that are not navigable in the ordinary sense but are classified as raftable. The first category may be conveniently subdivided into those capable of carrying the regulation *péniche*,

¹ The fact that the waterways in France are to some extent protected from competition makes it difficult to assess the importance of the geographical factor.

² Measured from the socket of the arch of the bridge or tunnel.

or canal barge, ~~only~~, and those which, like the Rhine and lower Seine, can carry and require a bulkier and heavier type of craft—the *chaland*.

The water transport system of France falls naturally into a number of groups of waterways more or less intimately linked together. These are :

1. The *Northern or Flanders group*, which may be subdivided into the Dunkirk system, the Lille system, and the coal-field system. These waterways are connected with those of the Paris basin on the one hand and of Lorraine on the other, and in addition they are intimately bound up with the Belgian waterways.
2. The *Seine or Paris basin group*. This includes the major tributaries of the Seine which converge in the neighbourhood of Paris. It is in communication with the French Flanders group and the Belgian canals, with the sea via Rouen, with the Lorraine and Rhine system, with the Rhône-Saône canal, with the Loire, with the Garonne and with the minor canals of Brittany.
3. The *Rhine and the Alsace and Lorraine canals*. This system gives France an outlet to the sea via the ports of Rotterdam and Antwerp, and is in connexion with the waterways of Burgundy, the Paris basin, and, via the Meuse, with Belgium.
4. The *Burgundian group*, which is linked with the Loire, Seine and Rhine systems.
5. The *Lower Loire*, which is connected with the Seine and the Brittany canals.
6. The *Southern group*, including the Rhône with the canal to Marseilles, the Canal du Midi, with its Languedoc extension to Sète, and the Garonne, with its lateral canal.
7. The *Armorican system*.

Of these groups the Flanders Seine, and Rhine groups are immeasurably the most important. The traffic carried on these systems, as given in the official reports, shows this at a glance.¹

We will proceed now to summarize the characteristics of the main groups, both from the point of view of the geographical conditions that help to make or mar their usefulness and also from that of their economic rôle in the transport system of the country.

1. The *Northern, or Flanders, system* of waterways is based on the rivers Sambre, Escaut (Scheldt), Scarpe, Lys and Aa. The Sambre, Escaut and Lys take their rise in the hills of Artois,

¹ See *Statistique de la Navigation Intérieure* (annually).

a region where the underlying rock is composed of chalk capped by heavy clays. This region, as a result of its elevation and of the trend from north-west to south-east is also a region of relatively heavy rainfall.¹ The effect on the régime of these rivers is to make it regular, for the underlying permeable rocks mitigate the swift run-off that would otherwise result from the elevated

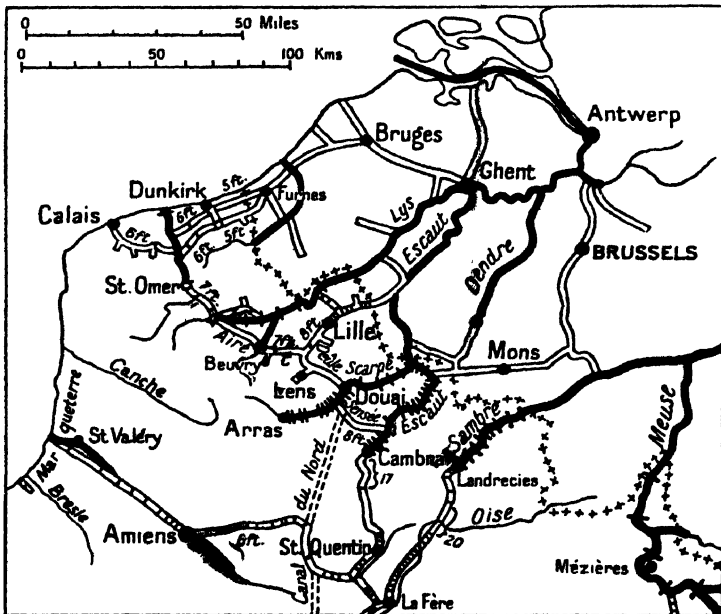


FIG. 94. THE NORTH-EASTERN SYSTEM OF WATERWAYS.

(Solid black lines indicate navigable rivers; double lines indicate canals; Locks are shown by cross-bars.)

clay surface, and the storage of water in the underlying chalk, which restores it to the rivers by springs in the valleys, means that a supply of water is continued during the dry season except in periods of prolonged drought. The fall of the streams during their passage through the chalk plateau is such as to preclude their utilization for navigation, although they play an important rôle in supplying water and power for industry.²

When they reach the plain of Flanders the streams are augmented by a great flow of water in the form of rivulets, rising in springs from the foot of the chalk edge.³ Their course is checked at the same time, with the result that there is a tendency in all

¹ See Fig. 3.

² See p. 178.

³ See Fig. 34.

of them to spread their waters in flood-time. On the other hand, the gradients being slight, it is not necessary to have a very large number of locks. We have seen how generations of regulating and draining have made possible the control of the Flanders rivers, which are all more or less canalized. They flow to-day through the great trenches that their waters carved in earlier times, but now their flood waters are, to a large extent, confined and their outflow to the sea is expedited. The Sambre and the Escaut with its tributary the Scarpe, owing to the trend of their channels through the industrial regions of the Nord and Pas-de-Calais departments, and to their continuance through the industrial regions of Belgium, are among the most important feeders of the navigable system. The maps¹ show the relation of the rivers to the coal-field, to the connecting and derivation canals, to the centres of exchange, to the main lines of railway, and to the ports of Calais, Gravelines and Dunkirk.

The geographical factors that have especially facilitated the development of this canal net are, then, the level nature of the country, which affords easy communication between the river-basins, the natural trenches and gaps cut by the streams into the low relief of the plain, the adequate and relatively even seasonal distribution of rainfall, the steady flow from the springs in the chalk rim of the basin and the presence of the coal-field, for which the canals form excellent distributors, and the industries based upon the coal-measures, which require heavy material, such as fuel, iron-ore, lime and sand. In addition to these advantages we must consider the relatively easy communication, across the Sill of Artois, with the Seine navigation and the market of Paris. Disadvantages are the closing of the system from time to time by ice, and the difficulty of conserving water during periods of drought.

A short section of the navigable Sambre lies within French territory; the canalized Lys is navigable from Aire to the Belgian frontier; the Scarpe and Escaut are also navigable for considerable stretches in France. These rivers are connected with one another and with the waterways of the Seine basin by a number of important canals.

Canal construction has been a necessity in Flanders for drainage purposes, and the adaptation of the system for transport is a happy turning to account of what would otherwise be merely a handicap.

First in importance come the *coal-field canals*.

The Aire and Deûle canals form the chief water route of the coal-fields of the Nord and Pas-de-Calais departments. The

¹ Figs. 39 and 95.

former runs from Aire on the Lys to the Deûle canal at Bauvin. Its length is twenty-five miles and its depth the regulation six feet. It has the great advantage of being able to dispense with locks, except for the double lock at Guinchy. The *Chemin de Fer des Houillères* has in this canal a useful annexe. A number of important mines have wharves upon it. Béthune¹ is the great

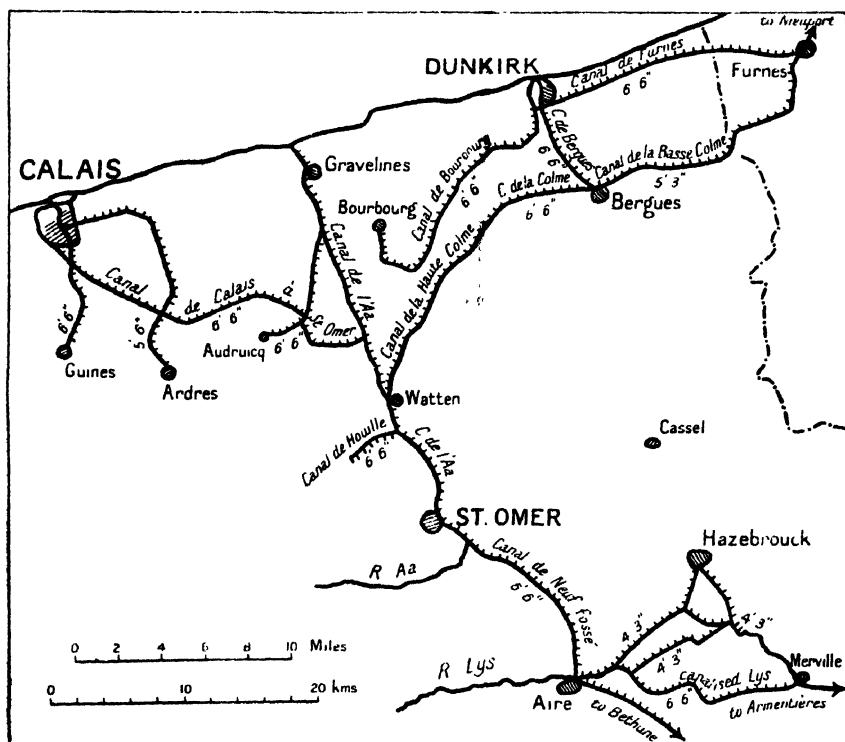


FIG. 95. THE CANALS SERVING THE CHANNEL PORTS.

(Figures refer to navigable depths)

distributing centre of the western part of the coal-field, and exports to Paris, Roubaix, Lille and Lyons by water, about 500,000 tons going in each direction. Apart from the private coal wharves, the traffic of the port is small, consisting mainly of building material.²

The Deûle canal continues the line of the Aire canal across

¹ Béthune, like Valenciennes and Lille, does most of its traffic through private ports, but a project is under way to develop a public port attached to the S.N.C.F.

² In 1936 the freight handled by the canal port at Béthune totalled 1,318,000 tons; it was the sixth inland port of France.

the coal-field in a south-easterly direction to the Scarpe at Escarpelles, and sends a branch northwards to serve the Lille-Roubaix area and connect with the Lys. From this a sub-branch passes to Roubaix and crosses the frontier into Belgium, and thence to the Escaut at Espierres, by which it connects with Ghent. The traffic on the middle or Lille section is very active, large quantities of coal passing down to the Lys, chiefly from the Brouay-Anzin district. Half the tonnage carried in 1936 consisted of coal. The canal distributes sugar-beet that comes by water from Belgium to the French refineries and distilleries of Picardy and Artois.¹ It receives wool from Dunkirk, soda from Dombasle, salt from Varangéville and Moussey, and coal, pit-props, pyrites and grain from Belgium. The tonnage on the Lille section of the canal has increased steadily of late years.²

The southern section of the Deûle canal, which links the Aire canal to the Scarpe near Douai, has a heavier traffic still, principally of coal. Douai (see Fig. 96), is the chief coal dépôt of northern France. The Scarpe-derivation canal encircles the town, giving it a double water frontage. From Courrières, near Pont-à-Vendin, a short branch canal leads to Lens and serves two important colliery ports—Harnes and Auby. Seven-eighths of the tonnage in 1936 consisted of coal.

The Sensée and St. Quentin canals continue this important function of coal transport to the Oise, the Seine and Paris, utilizing a short section of the canalized Scarpe. The Sensée canal is deeper than the others, having a depth of eight feet. It has a very heavy traffic of coal towards the Escaut. Works to deepen the bed of the canal in the tunnel by which the St. Quentin canal communicates with the Oise basin, and for the widening of the tunnel, were completed in 1928 and have doubled the carrying capacity of the canal.

The coastal canals behind Dunkirk have a certain importance, but the water-supply in this section is not always satisfactory, and traffic is sometimes much impeded, as, for example, in 1928. This is particularly so on the Canal de Furnes, which joins Dunkirk to the Belgian Nieuport canal. From Dunkirk three canals branch, connecting the port with Calais, with St. Omer and the coal-field via the Aa and the Neuf-fossé canals, and with Bruges and Ghent via Furnes and Nieuport.

Dunkirk sends inland by water small quantities of coal, ores, fertilizer, timber and machinery, and receives potash fertilizer and other industrial products, as well as coal which reaches the

¹ The French Customs Duty imposed in November 1929 caused a great drop in this item of traffic.

² The tonnage of goods dealt with in 1936 at Lille amounted to 360,000 tons.

town from Béthune, by way of the Aa and the Bourbourg canal. The agricultural products that pass towards Dunkirk by water include flour, chicory, sugar and cattle-cake, which are exported

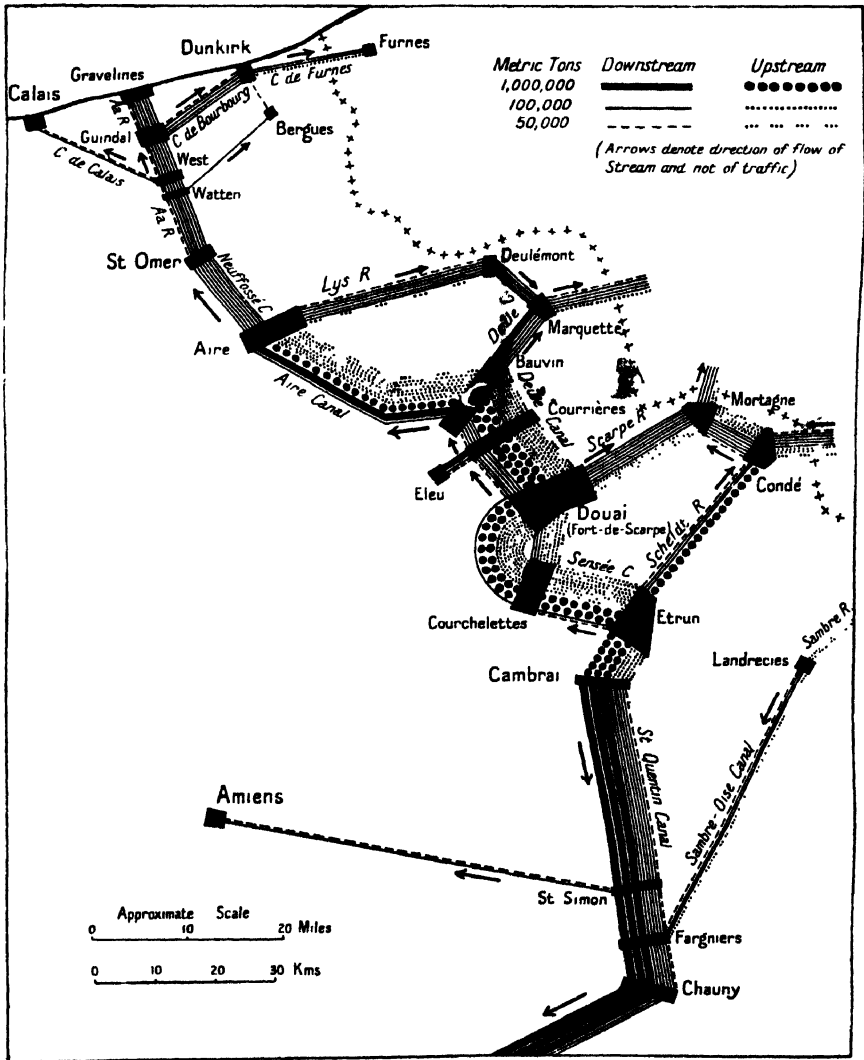


FIG. 96. COAL TRAFFIC ON THE NORTHERN WATERWAYS.

by sea, raw sugar going to England. The sugar-beet products come from both Belgian and French Flanders. By the Calais canal Dunkirk receives Boulogne cement. In its functions as

canal and seaport, Dunkirk suffers from competition with Antwerp and Ghent, which are better served by canal and by rail.

The relatively small catchment area of the river Aa, resulting in an unreliable water-supply for the canals, has favoured the competition of the railway in this area. Leffrinckouke, on the Canal de Furnes, has a large canal traffic; Uxen also, which has private wharves belonging to an iron and steel firm of Firminy near St. Etienne. The latter place sends partly manufactured iron and steel goods, machinery and iron pipes, to Dunkirk, for export to the French colonies.

The traffic on the Somme is not very important.¹ The gradient of the river in its lower reaches is so slight, the seepage from the plateau edges so constant, and the formation of peat so rapid that, unless carefully drained, the valley-bottom deteriorates to marsh. This occurred owing to neglect during the war of 1914-18, and, owing to the raising of the river-bed by the formation of peat, resulted in serious flooding of the cultivated land.² The river meanders greatly, hindering traffic. Certain sections of the river are not used at all, a lateral canal joining Abbeville and St. Valéry. A certain amount of coal reaches Amiens by the St. Quentin canal, also agricultural produce of which the most important is sugar-beet for the refineries of Artois and Picardy. There are twenty-five locks in the ninety-seven miles between the junction of the St. Quentin canal at St. Simon and St. Valéry-sur-Somme.

2. THE SEINE GROUP. This group of waterways consists of the navigable Oise, Aisne, Marne, Seine and Yonne in the eastern section of the Paris basin, and of the lower Seine in the west, also of their lateral canals and a number of connecting canals. With these we shall have to consider the communication canals which lead to Flanders, the Rhine, the Saône, the Loire and the Garonne.

The basin of the Seine covers an area which, although exposed to Atlantic winds, is sufficiently far from the coast to miss the heavy rains of the maritime districts. The tributaries of the Seine, however, draw their waters from regions where a westerly exposure and greater elevation rather more than compensate for distance from the sea. The succession of limestone plateaux traversed by these tributaries tends to regularize the flow of water to the drainage channels. When the water-table is high in the winter half year a minimum flow is secured to the rivers. Sudden rises occur, chiefly in the winter half of the year, and are due to heavy rains in the upper Marne, Seine and Yonne basins, more particularly in the last, which not only collects the rapid

¹ In 1936 the Somme freight only amounted to 764,000 tons.

² See *Reports of the Senate*, 1925, p. 488.

streaming of water from the granite of the Morvan, but receives the muddy streams from the Lias Clays of Auxois. The streams of the impermeable rocks rapidly become raging torrents, and the Yonne deposits great banks of mud from Auxois and sand from the Morvan Massif in its own bed and in the channel of the Seine, the character of which thus changes for a space below the confluence from the conditions characteristic of a river of the limestone plateaux. For the most part, however, difficulties of navigation are not very frequently encountered. Low-water

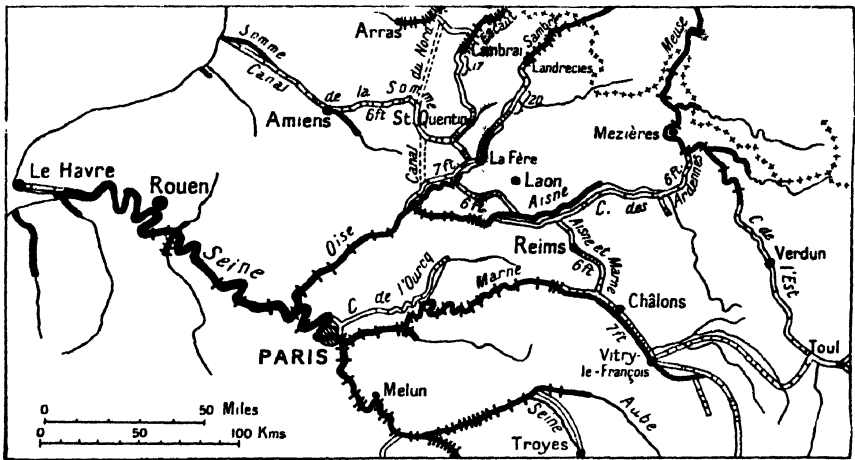


FIG. 97. WATERWAYS CONNECTING THE PARIS BASIN WITH THE NORTHERN COAL-FIELD.

obstacles, are, owing to the subterranean supply from the limestone, relatively rare. Those due to floods are more common and more serious. If the tributaries should all rise at once the bridges are no longer negotiable, the navigable channel ceases to be recognizable, and the barges, owing to the current, become unmanageable. Moreover, to obviate the danger of flooding the occupied land, sluice-gates have to be opened to let the water get away as rapidly as possible. Fortunately the converging waters do not as a rule all rise at once. On the whole, the Seine may be considered as an orderly river, offering unusual facilities for navigation for a great part of each year. As Vidal de la Blache has said of the river, 'Sans être inoffensif il est disciplinable'.¹

The Oise with its lateral and connecting canals carries more traffic than any other member of the Seine system, for by its link

¹ Vidal de la Blache : *Tableau de la Géographie de la France*, p. 142.

with the St. Quentin canal it draws on the northern coal-field, by the Sambre-Oise canal it taps the Belgian coal and coke supplies, through its tributary the Aisne and the Canal des Ardennes it gives access to the Meuse metallurgical district of Mezières. The Oise is not navigable above Chauny. Apart from a few head-waters that it draws from the southern edge of the Ardennes, it is flowing through a deep trench which it has cut in the chalk plateau covered with Tertiary deposits. With the exception of the waters brought to it from the Gault Clay by the Thon, which may give trouble after heavy rain, it is almost entirely fed by springs from the chalk, so that a regular supply of water is ensured to the *Sambre-Oise canal*, and there is little silt. In the broad valley through the chalk the canal has a fairly steep gradient, necessitating many locks; there are thirty-five on the south side of the three-mile water-parting between Sambre and Oise. The course of the Oise itself is meandering and braided, and the valley would be marshy but for the drainage effected by the canal. At La Fère a short branch passes to the St. Quentin canal at Fargniers. This section is important, for at Beautor and Fargniers there are barge-building yards, and in the neighbourhood of Tergnier the S.N.C.F. has large shops and stores.

Near Chauny where the river nominally becomes navigable, it receives the Aisne-Oise canal from Bourg. This normally¹ brings the salt from Varangéville in Lorraine to the very important chemical works at Chauny, which supply soda for the local glass-works, as well as making sulphuric and nitric acid, and latterly superphosphates. This canal utilizes the valley of the Ailette, which skirts the southern border of the forests of Gobain and Coucy. Although it has a depth of eight feet, the Oise, between Chauny and Janville, is not much used, for it has a very bad bend at Pimprez. A lateral canal with a depth of seven feet takes most of the traffic (coal from the north and building material in both directions) over this section. At the junction of four canals administered and maintained (with the exception of the Sambre-Oise) by the State, and with important rail connexions, Chauny bids fair to become an important industrial centre with iron- and steel-works, rolling mills, mechanical engineering, wire-drawing and bronze-works, etc. At Beautor and Chauny, the making of special machinery for the great St. Gobain glass-works, in addition to the important chemical works already mentioned, requires a considerable amount of coal and raw material. Transport on this section is mainly through-traffic, however, and amounted in 1936

¹ The tunnel by which the canal crosses the divide between Oise and Aisne was destroyed in the final retreat of the Germans and has been completely rebuilt.

to about 6·07 million tons. At Noyon the Canal du Nord, the construction of which had reached an advanced stage when the war of 1914-18 broke out, and was very seriously damaged by the combatants, will, if and when repaired and finished, join the Oise canal. It was designed to link the valleys of the Sensée and Oise and thus shorten the water route between Lille and Paris and to relieve the traffic of the St. Quentin canal, which was overloaded.¹ At Janville the canal, which cuts off some of the largest loops of the Oise, comes to an end and the Oise itself takes up the navigation. Two miles below Janville it is joined by the canalized Aisne.

(The *Aisne* is canalized from Celles, near Condé, to its junction with the Oise.) Above Celles there is a lateral canal which takes off near Neufchâtel where the Ardennes canal joins. This last, and the upper raftable section of the Aisne, bring down timber from the Ardennes valleys. There is little but transit traffic on the lateral canal, as it traverses the chalk plateau, and there is only horse traction provided, in contrast to the electric and steam traction on the St. Quentin and Oise canals. The total tonnage carried on the canal in 1936 was only 1·3 million tons. The canalized Aisne from Celles downwards has about the same traffic, but this is only one-third of the traffic carried in 1913. German, Belgian and French coal is the main downstream cargo.

From Compiègne downwards the Oise traffic becomes heavier, coal being still the main cargo. Much coke comes upstream from Paris (Gennevilliers and Nanterre) for the glass-works of Compiègne and to the salt district of Varangéville; salt comes downstream from Varangéville for the chemical and dye-works of Villers St. Paul and Creil, pig-iron and metallurgical coke come from Frouard in Lorraine to the important metallurgical and structural engineering works of Creil and Montataire; timber comes up for the wood industries (packing-cases, wood-turning, etc.) of Marny-les-Compiègne and La Croix-St. Ouen and for constructional and building purposes. The river port of Creil has the advantage of proximity to a very important railway junction, and is well equipped with both public and private wharves. Montataire, on the other side of the river, has barge-building yards. Wharves for coal, timber, ballast, and plaster and building stone are found at intervals on the banks of the river as it passes through the forests of Halatte and Chantilly to Pontoise, just below which it describes a great northward loop before entering the Seine. There are only seven barrages on the Oise between Compiègne and the Seine. At Pont-St. Maxence,

¹ A scheme for a much shorter canal, but of a type to meet modern requirements, has been taken in hand.

forty-three miles above the confluence, the altitude is only 105 feet above sea-level. The Oise below Janville carries more traffic than any of the other Seine tributaries.

The *Marne*, which has a much greater volume than the upper Seine, is also a less reliable stream for navigation, mainly because of the great development of the Gault Clay in Le Perthois. It is not canalized effectively above Epernay. From Epernay to Charenton, at the confluence with the Seine, it has a depth of seven feet three inches and can be navigated at most seasons by vessels drawing five feet nine inches. Various difficult sections of the waterway are doubled by canals. At Condé the Aisne-Marne canal joins the Marne. It is a waterway with a length of thirty-six miles and a considerable traffic in coal, timber and building material.)

The Marne navigation is in touch with the railways at La Ferté and Lagny; the lateral canal joins the Marne-Rhine canal and the Marne-Saône canal at Vitry-le-François, from which is distributed basic slag brought by water from the smelting-works of Neuves Maisons or Frouard in Lorraine. Coal from the Sarre basin and Liège, sand and gravel from the Metz district or from Neuves Maisons form the main part of the traffic above Epernay. Below Epernay, where the traffic comes on to the river itself, building material and coal are still the principal cargoes, and we find pit-props from the forests on the Tertiary sands being loaded for shipment to the Nord coal-field as return cargo. Sand also travels back to Lorraine, and from farther downstream plaster of Paris for cement-making goes from the neighbourhood of Gournay and Meaux to Alsace, Lorraine and Flanders.

The upper Seine and Aube, squeezed between the more affluent Marne and Yonne, whose head-waters drain impermeable rocks, have developed few tributaries in the limestone and have but a meagre water-supply. Neither is navigable above their confluence at Marcilly, but the Seine has a short lateral canal from Troyes to that point. The traffic is negligible, however.

The upper Seine is nominally navigable up to Mery by a lateral canal, which is, however, not used above Marcilly. From Marcilly to Paris the Seine is canalized and is navigable not only by the ordinary *péniche* but by the heavier Marne barges up to 600 tons and by steam barges, which are being increasingly used. There are only thirteen locks between Marcilly and Montereau. From Montereau-sur-Seine and neighbouring ports grouped at the junction of Seine and Yonne sand, bricks, tiles and other building materials are sent towards Paris. Montereau has large potteries. It has a good deal of traffic because it is in contact with the S.N.C.F.

The *Yonne* is the 'black sheep' of the Seine group of rivers. Drawing its waters from the impermeable and deforested uplands of the Morvan and from the Lias Clays of Auxois, its head-streams are torrential and its flow irregular and violent. Its valley is used by the Nivernais canal as far as Auxerre.

The principal commodity carried on the *Yonne* is timber. From Armes, Clamecy, Chatel Censoir and other small ports wood, chiefly pit-props, is floated down the last ten miles of the non-navigable course to Auxerre. The wooded country of the upper Armançon, served by the Burgundy Canal, also exports a large quantity of pit-props from such collecting centres as Montbard and Tonnerre, so that there is a convergence of pit-prop traffic along the waterways that drain the slopes of the Morvan and Auxois. Building material is also important.

It has been said that the life of the Paris basin is concentrated at the centre and in the valleys that converge on it. This applies to both canals and railways. To-day there is a constant flow of goods of all descriptions towards Paris, most of which are consumed within this centre, some, however, being transformed and re-distributed. Fuel building material and food-stuffs find a steady demand there and constitute a large proportion of the goods carried by the waterways. In addition there are raw materials for the industries that congregate round the capital beside the waterways and railways, and have greatly increased in the last fifteen years. Paris, like all great metropolitan centres, must be regarded as an industrial area, but its main industries are concerned in providing for its local market. As far as heavy goods for export are concerned, it produces mainly by- and waste-products. First among these come the vast amounts of refuse that must be evacuated from the city. This is sent out by barge and dumped in the quarries excavated for building stone in the outskirts of Paris. This refuse, forming so important an item by weight, bulks very large in the figures of water traffic of Paris, which are apt to be misleading, therefore, if taken as indicating the importance of the trade carried on in the port. Paris consumes very large quantities of coal per annum in the manufacture of gas. The main by-product, coke, is exported in large quantities as far as Chauny in the department of Aisne, at the junction of the St. Quentin and Oise canals, and to Varangéville and to other centres, to be used chiefly in household stoves. The coal reaches the capital either upstream via Rouen (English, German, Polish and Russian coal, the first about three times as much as the rest put together) or downstream from Belgium and north-east France.¹ Some coal is distributed from Paris by water. Iron

¹ See Figs. 96 and 98.

comes down from Novéant in Lorraine, cement from Pagny-sur-Meuse, soda from Dombasle and St. Philin, and salt from Varangéville. Of the building materials that bulk so large in the traffic of the port of Paris, sand and gravel form the most important freight. They are shipped from Gennevilliers. Building stone comes from as far afield as Euville, Commercy and Lerouville on the river Meuse.

Industrial Paris, which stretches from Ivry above the city

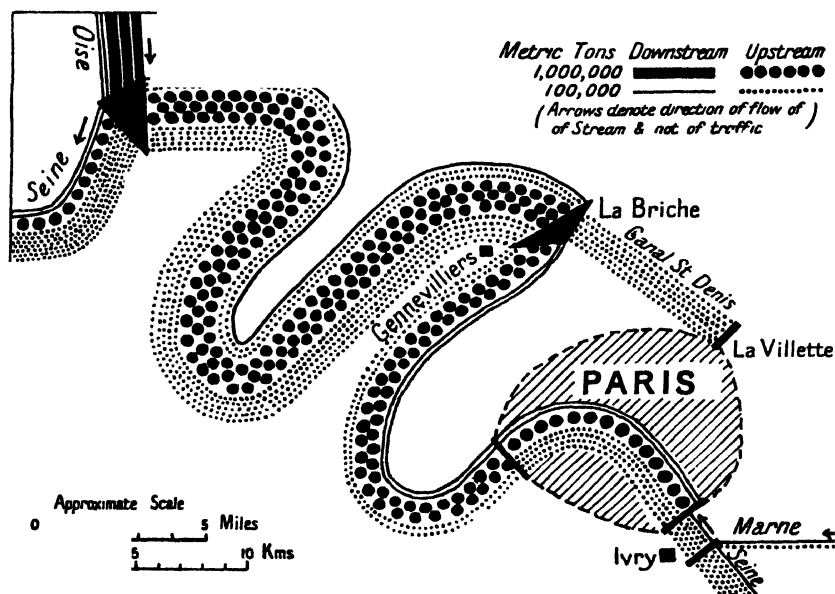


FIG. 98. COAL TRAFFIC ON THE PARIS WATERWAYS.

to Gennevilliers below, has already been described in the regional study of the Paris basin,¹ but it is relevant to add here some details concerning the movement of goods within the port. There is no particular concentration of traffic at any one point on the river. The quays stretch up- and downstream for many miles. There are eight miles of navigable river within the city itself. The depth throughout the port is ten feet.

Traffic is made difficult and sometimes dangerous by the twenty-seven bridges that span the main channel. There are twelve quays with a total length of 40,000 feet, and the banks of the river are concreted. The river is not the only navigable way within the city. A little way upstream the Canal de St. Martin takes off and passes north through the Marais to La Villette in

¹ See p. 142.

the industrial plain where it joins the Canal de l'Ourcq and the Canal de St. Denis. This last provides a cut four miles long and ten feet deep to La Briche at the northern extremity of the great loop of the Seine, that lies west of Paris, thus short-circuiting the bend of the Seine that encloses the Bois de Boulogne. The Canal de l'Ourcq has not the importance of the other two, for its depth is only four and a half feet, and the minimum air space beneath the bridges is only nine feet. Its value is mainly as a derivation canal. Nevertheless, the first mile or two of its course, where it passes through the busy industrial suburb of Pantin, carries a certain amount of traffic. Pantin imports carbonate of soda from St. Philin. On the St. Denis canal the port of Stains at Aubervilliers had a traffic in 1936 of 230,000 tons. Large gas-works near here consume much coal and export coke and other by-products. The S.N.C.F. has sidings too on this canal, which make it one of the busiest parts of the Port of Paris.

The section of the navigable Seine immediately below the Isle St. Denis and between this point and the confluence of the Oise near Conflans Ste. Honorine, may be considered almost as an annexe of the port of Paris. It is a very important stretch of waterway. The depth is ten feet. The river is lined with public and private quays, and there is much traffic.¹ Gennevilliers, a large industrial suburb, receives coal from Rouen and from the Oise, pig-iron and steel from Novéant in Lorraine. As a return cargo it sends back coke to the salt-works of Varangéville. The importance of this port is largely due to the sidings of the S.N.C.F. Apart from the movement of coal and partly worked iron, and iron and steel goods such as iron pipes from Pont-à-Mousson, there is a large influx of building material in the form of sands and gravel, cement and building stone. Stone is quarried in the steep bluff that carries the forest of St. Germain and at the Carrières St. Denis below Argenteuil.

The traffic of the lower Seine is divided into two sections: that between Paris and Rouen and that between Rouen and Le Havre. The first is essentially fluvial, the second mainly maritime.

From the point of view of physical conditions the lower Seine is favourably situated on the whole. The main essential for navigation—a sufficient depth of channel—is there. There is a depth of ten feet as far down as Rouen, maintained by weirs. Below Rouen the depth is affected by the tides and varies from twenty-five feet at high water to two and a half feet at low-water spring tides.²

¹ The freight carried on this section in 1936 amounted to 9.6 million tons.

² Levainville: *Rouen*, 1914-19, p. 6.

We must refer the reader for the account of the activities of the port of Rouen to Chapter IV, which gives a detailed description. Here we will be content with a summary of the river transport.

The Paris-Rouen section is devoted to the transport of goods either from Rouen or from the mouth of the Oise to Paris. It consists chiefly of coal.¹ The other important article of water transport in this section is building material, particularly sand, which passes down the Oise from Cassicourt and up the Seine. About 760,000 tons of mineral oil came into Rouen in 1938, much of which was passed on to Paris. Wine, chiefly from North Africa, forms another upstream cargo carried at certain seasons. Phosphates and pyrites fertilizer pass upstream throughout the year. A small amount of iron-ore comes in from Algeria and also sometimes from Sweden. Wood-pulp for the paper-works of Paris comes in at all seasons and timber is forwarded during the summer and autumn months. The upstream traffic from Rouen has to compete with the railway, which takes slightly less than half the goods exported from that port. A relatively small amount of traffic passes downstream from Paris, except in the short section which lies between Paris and Conflans Ste. Honorine at the junction of the Oise. Traffic coming downstream to Rouen consists mainly of building materials of various kinds.

Rouen plays a double rôle on the waterway. It is the outport of Paris in particular, expediting chiefly goods that arrive by sea in ocean-going boats and which have to be unloaded into barges. In addition, the port caters for the needs of the industrial city behind it and for the industries which have grown up on the Seine banks in the neighbourhood. Cotton does not favour the water way as a rule. It is forwarded chiefly by rail. Salt and soda for the textile industry come by water from Lorraine, Dombasle and Varangéville. Building stone comes from the Corallian limestone regions of the Meuse. For the agricultural lands of the plateaux Rouen imports phosphates.

Below Rouen there is little river traffic, properly speaking. Goods carried up- and downstream are, for the most part, carried in sea-going boats. A small amount of goods for Rouen is loaded at Le Havre, and includes very much the same type of goods as the traffic that comes in direct from the sea—coal, timber, mineral oil, paper, cereals, sugar, ore, etc.

We must note certain drawbacks to Seine navigation. They include, first, the winding nature of the river, particularly of the

¹ See *La Navigation du Rhin*, January 1931, p. 21. Coal, etc., sent upstream from Rouen in 1938 amounted to about 2.1 million tons.

lower stream, where the huge loops of the meanders are so deeply incised as to make straightening of the course impossible. The length of the waterway from Le Havre to Paris amounts to about 220 miles. Eliminating the meanders the distance is 120 miles. The Tancarville canal avoids the difficulties of the navigation of the estuary for small vessels.¹

The tidal current for modern navigation is a mixed blessing, for although it provides motive power and at high water an increased depth, traffic is apt to be interrupted at low water for any but the smallest vessels, and approach to the wharves is rendered difficult. In the Seine the current is very strong, and a bore is formed, known as the *egre*, which is troublesome to small boats.

3. *The Rhine and the Alsace and Lorraine canals.* A detailed study of the geography of the Alsatian Rhine and of the port of Strasbourg will be found on pp. 380-88, but it will be convenient to summarize here the main facts relevant to the navigation and to the development of the port up to the outbreak of the war of 1939-45.

Navigability of the Rhine. From the Franco-German frontier at Lauterbourg to Strasbourg the channel has a mean depth of 2.50 metres, while from Strasbourg to the Kembs barrage below Basle there is a mean water depth of 2 metres. These facts are, however, misleading unless the régime of the river is taken into consideration. The Alsace Rhine has an Alpine régime, with low water in winter during the winter freeze, and very high water in early summer during snow and ice melt. During low water, grounding and ground ice are dangers, and during high water the current, which flows at between 8 and 9 kilometres per hour, makes the barges unmanageable² and the low bridges impassable. Thus the river is navigable between Strasbourg and Basle for fully loaded barges of 1,000 to 1,500 tons for only about a quarter of the year.

Regularization of the Rhine to Strasbourg, improvement of the Rhine-Rhône canal, construction of the Kembs barrage to enable French barges to cross the Rhine in safety, widening of the Huningue canal lock below Basle to take the Dutch *péniches* after they have crossed the Rhine, were improvements instigated and carried out in the interests of Alsace and the port of Strasbourg in particular and of France in general. Regularization of the river above Strasbourg was carried out mainly in the interests

¹ About one million tons of goods were carried upstream through the canal, and 600,000 tons passed down in 1936. The cargoes are carried in sea-going vessels. In addition a small number of *péniches* made the journey through the canal.

² The average gradient is 1 : 100,000.

of Baden and Switzerland to avoid as far as possible transshipment of goods destined for Basle by canal transport through French territory via Strasbourg.

A summary of works undertaken to improve and extend Rhine Navigation is as follows :

1866. Completion of the Marne-Rhine, Sarre Colliery and Strasbourg Junction canals.

1907. Work on the regularization of the Rhine above Mannheim begun. Work was begun on two junction canals to connect the Ill port of Strasbourg with the Rhine.

1914. By this date a fairly reliable depth of channel of two metres had been assured up to Mannheim, and that port at the head of large-scale navigation had achieved a freight tonnage of 10 million tons per annum.

1918. The development of a new port above the bridge at Strasbourg went on rapidly, with storage for coal, oil and grain, together with a coking plant and other industrial establishments.

1919. The Alsace section of the Rhine-Rhône canal was deepened and improved.

1925. The lock at Huningue was reconstructed to accommodate 280 ton barges from across the Rhine.

1927. The Kembs Barrage was begun and the Strasbourg petroleum port was opened.

1928. The Swiss began the development of the port of Basle.

1932. The Kembs Barrage was finished.

1934-35. The regularization of the Rhine channel to Basle was carried out, including the Istein rapids section. The resulting alteration of the charted channel below Strasbourg was detrimental and involved heavy dredging.

1939. At the outbreak of war in 1939 the new port of Strasbourg above the bridge was still incomplete.

The *Rhine-Marne* canal, between Strasbourg and Vitry-le-François, is 195 miles long. It has a depth of $6\frac{1}{4}$ feet and has 178 locks, 52 east of the Vosges and 126 on the west. Apart from the large number of locks, and from the fact that they are difficult of approach, this waterway is not altogether satisfactory. In spite of the heavy rainfall of the Vosges, the steep gradients mean a rapid run-off of water, and there is a lack of satisfactory reservoirs, so that, in a dry year, the water-supply is apt to be insufficient. Moreover, the rivers that feed the canal are torrential, and a number of silted stretches interfere with navigation. Nevertheless, so important are the industrial areas served by this canal, that the traffic amounts to nearly eight per cent of the total traffic of the French inland waterways. About half of the traffic is in transit, about one-quarter reaches the canal from other

waterways, leaving a relatively small amount to represent the commerce of the areas traversed.

The canal starts from Strasbourg, utilizes the Zorn valley to

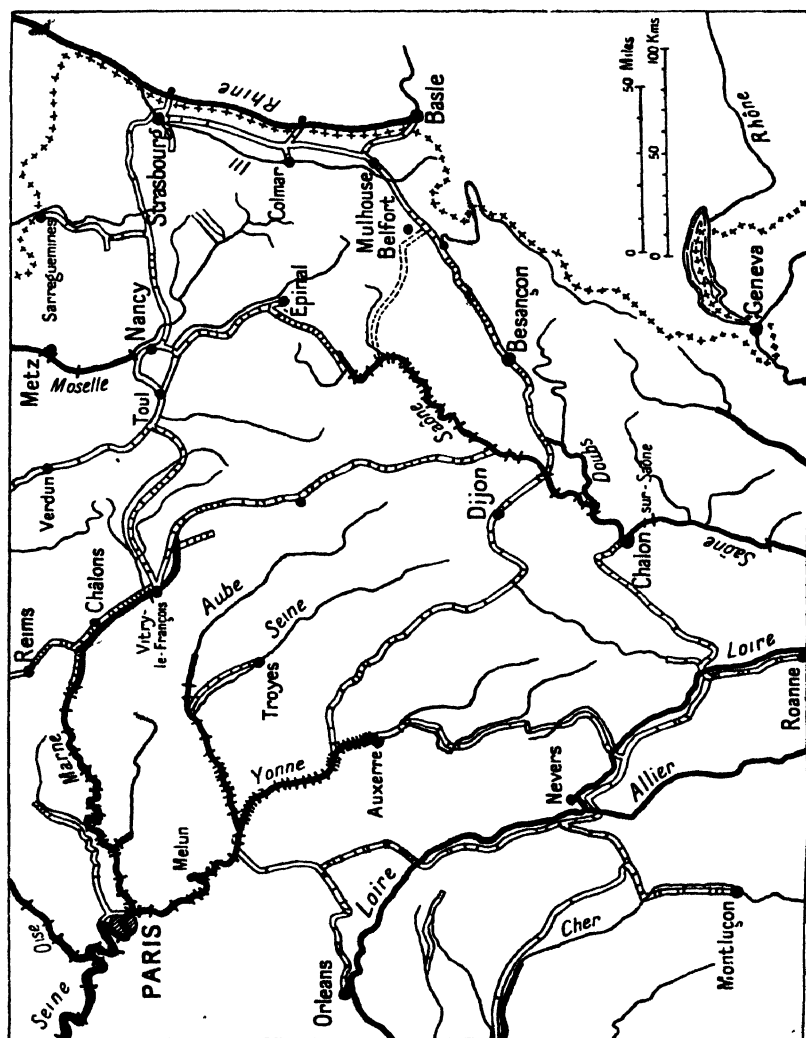


FIG. 99. THE WATERWAYS OF ALSACE-LORRAINE AND BURGUNDY AND THEIR CONNECTIONS WITH THE PARIS BASIN.

reach the summit of the Vosges, which it crosses by two tunnels, one 547 yards long and the other 2,500 yards long, between Arzviller and Niederviller. On this first section the most important item of transport is coal and coke, Ruhr and Dutch Limburg coal and coke passing to the Lorraine iron industries,

and Sarre coal coming to Strasbourg for distribution. The canal carried a total freight of 5.1 million tons in 1936, or 8 per cent of the total conveyed by French waterways. A certain amount of building material is moved and sand and gravel is brought down from Messein in Lorraine. After crossing the water-parting, the canal taps the salt area of Lorraine at Moussey, picking up salt for the Seine and the north. At Dombasle, St. Nicolas, Varangéville, St. Philin and La Neuveville it receives cargoes of soda, refined and rock-salt, and gas coke, which it dispatches to the textile areas of Reims and Rouen and the lower Seine and those of Lille and Lyons, and to the chemical works of Chauny. Near Gondrexange the Sarre colliery canal comes in,¹ bringing coal for distribution in both directions. The canal reaches the Meurthe at Dombasle and follows it to Maxéville, just below Nancy, where the Meurthe becomes navigable, just before its confluence with the Moselle. Nancy has a considerable traffic, importing coal and wheat from Strasbourg and exporting, from its outport of Maxéville, iron-ore to the Sarre at Burbach and partly worked iron and steel to Bayard, Bussey and Brousseval in the upper Marne. Large quantities of cement are distributed by water also from Maxéville.

At Frouard the canal meets the canalized Moselle as it returns from its westward excursion into the plateau. Iron and steel are exported to the metallurgical industry of the centre and upper Marne. The canal now follows the river upstream to Toul, when it enters the Toul gap, cut by a former course of the Moselle, within which it tunnels beneath an obstructing spur of the plateau, to emerge in the industrial district of Foug and Pagny-sur-Meuse. Just below Pagny the Canal de l'Est joins the Rhine-Marne canal. From here manufactured iron goods and large quantities of lime and cement are exported, the lime going to the Sarre coal-field for fluxing.

After crossing the Meuse at Pagny the canal climbs the divide between the Paris basin and the Meuse valley, passing under the summit at Mauvage by a tunnel 5,330 yards long. This divide is the most important obstacle that the canal encounters. It then uses the Ornain valley to descend to Bar-le-Duc, to which it supplies coal in return for pit-props and fuel logs, which pass by the Canal de l'Est to Courrières on the northern coal-field, or in the direction of Nancy. At Vitry-le-François it joins the lateral canal of the Marne and the Marne-Saône canal.

The *Canal de l'Est* follows the Meuse from the Belgian frontier just below Givet to Troussey, where it joins the Rhine-Marne canal. It utilizes that waterway in the gap as far as Toul and

¹ See p. 490.

then the canalized Moselle to Messein, where it sends a branch north to Nancy, which joins the Rhine-Marne canal at Laneuveville. It follows the Moselle to the neighbourhood of Epinal, to which it sends out a short branch, and then crosses the water-parting to the Saône basin at Girancourt, utilizing the Coney river to cross the Vosges uplands. The depth of the canal is seven feet and its total length from the Belgian frontier is 260 miles. There are fifty-nine locks on the north branch, ninety-nine on the south, and there are four tunnels. This canal serves the iron district south of Nancy from which Neuves Maisons, Messein and Sexey-aux-Forges send iron-ore and pig-ore to the Sarre, to Strasbourg, to Roanne and to Lyons. From the same district, and from the port of Richardménil in particular, sand and gas coke are sent by water to Sarreguemines and Saarbrücken. Coal and coke from Strasbourg are the chief return commodities. Southwards, coal is the main cargo for distribution and transit, and comes from Maastricht by the river Meuse and the north branch of the Canal de l'Est and from Holland or the Ruhr by Strasbourg. The northern branch from the Belgian frontier to Troussey is chiefly engaged in transporting coal from Liège to the woollen industry of Sedan and to the iron-works of Charleville and Mézières. Lime, timber and building stone are carried northward in return. The timber—pit-props for the Sarre, stove logs, and rough timber for various destinations—comes from the neighbourhood of St. Mihiel and Sorcy on the Meuse. The building stone is found in belts of sand in the Oxford Clay zone and is exported from Euville, Commercy and Lérouville; it is sent to Paris, Brussels, Lyons and other distant centres. Lime is also sent from the same district to the iron-field of Nancy to mix with the arenaceous ores.

The *Moselle* is classified as raftable from Epinal to Frouard. The Canal de l'Est follows its valley and uses its waters in this section. South of Nancy it is useful in supplying the Pont-à-Mousson metallurgical district with coal and coke and lime and transporting the iron pipes and other manufactured and semi-manufactured articles to Lyons, Roanne, Strasbourg, etc. It carries iron and steel goods from Novéant to the Paris and Rouen district and redistributes coal from Novéant up- and downstream. Below Metz the river is only raftable through the Uckange iron-field to the frontier at Sierck. The German section of the Moselle has meanders so exaggerated and so deeply incised in the Rhine plateau as to be of little use for navigation, even if its régime were satisfactory. The main railway to Coblenz carries the iron and coal traffic between the Rhine and the iron-fields by a natural route traced at a higher level in the plateau, and only about half

as long. Works are in hand to canalize the river between Metz and Thionville.

The *Sarre Collieries* canal joins the Rhine-Marne canal to the canalized French Sarre at Sarreguemines. It brings iron-ore, lime and sand to the coal-field and carries back coal.¹ The chief port on the navigable Sarre is Völklingen, which receives iron-ore from Messein and lime from Void on the Meuse near Toul, and from Dombasle. The depth of the canal is six and a half feet.

The *Marne-Saône* canal takes off from the Marne at Vitry-le-François, taps the forest region of St. Dizier, feeds the metallurgical districts of Bayard and Bussy with pig-iron from Maxéville, crosses the plateau of Langres, and descends by a staircase of locks—forty-three in fifty-five miles—to Maxilly-sur-Saône. It sends a branch line to the metallurgical centre of Wassy-Brousseval to which it carries pig-iron.

The *Rhine-Rhône* canal takes off from the canalized Ill at Strasbourg, links that port with the cotton area of Mulhouse and sends a branch to Colmar. Coal from the great Strasbourg dépôt is the chief commodity carried. The canal has been reconstructed since 1918 and can now accommodate 300-ton barges. A very important branch, the Huningue canal, which diverges from the neighbourhood of Mulhouse and enters the Rhine near Basle is the first step in the great Alsace canal scheme.² It takes off above a great barrage at Kembs, which is designed to raise the level of the water and so enable traffic to reach Basle. It crosses the

¹ About 600,000 tons each way in 1936.

² By the Treaty of Versailles France may use water-power from the Rhine in Alsace, subject to certain conditions, among which is one that she shall not reduce the facilities for navigation on the main river. In 1919 the Société des Forces Motrices du Rhin brought forward a scheme for a lateral canal which should use Rhine water taken off by a derivation canal in the neighbourhood of Kembs. Opposition by Switzerland and Baden resulted in France's undertaking to construct a barrage of such a nature that it would improve the navigability of the river at Basle. The Rhine commission has approved a scheme brought forward by Baden and Switzerland for the regularization of the Rhine river to Basle. The difficulties of navigation of the Strasbourg-Basle section, it is argued, have of late years, been aggravated by the cutting back of the natural limestone bar at Istein, which has been forming increasingly serious rapids which must inevitably get worse as the river grades its course.

The Kembs barrage was begun in 1927; its sluices can be opened to let through the flood-water, and there are arrangements for allowing ice and silt to escape downstream. One of the difficulties to be overcome was the velocity of the current in the canal, for in the river at Kembs the actual speed may reach 13 feet per second. The power station which was constructed to use the fall at the barrage is capable of producing 140,000 h.p. One of the twin locks on this short canal of four miles is so constructed as to be able to take a tug and two barges side by side. The second lock takes smaller convoys or single boats. This work, which was finished in 1932, is the first stage of the Grand Canal d'Alsace, which, it was intended, should run parallel to the Rhine to Strasbourg, with eight sets of locks and power stations in all.

divide between Rhine and Rhône via the Burgundian Gate, follows the foot of the French Jura to Besançon and joins the Rhône at St. Symphorien.

A number of connecting canals join the rivers of the Paris basin to the basins of the Loire and Rhône-Saône. The *Nivernais* canal links the Yonne and the Loire lateral canal. It is 106 miles long and its maximum depth is only about five feet. It has 115 locks, 80 to climb the Yonne to the summit at 860 feet and 35 in the descent to the Loire. It is mainly used for the transport of timber from Clamecy—pit-props and railways sleepers, the former to the Nord district—though the traffic has fallen off of late years, owing to road competition. A tug is available twice in the 24 hours to tow barges between Decize and Auxerre.

The *Burgundy* canal joins the Yonne just below the junction of the Armançon river. It follows the Armançon valley and that of one of its tributaries by means of 114 locks for nearly 100 miles to Pouilly-en-Auxois, where it passes through a tunnel about two miles long to emerge in the Ouche valley in the Côte d'Or. Another 58 locks are needed to hold its waters up in the descent towards Dijon. Needless to say, there is little traffic over the summit, in spite of electric towage provided in the tunnel.

The *Briare* and *Berry* canals serve the metallurgical region of Nevers. The former joins the Seine and Loire via the Loing. It brings pig-iron from Neuves Maisons and Novéant. It is 34 miles long and 6½ feet deep and has 36 locks. Limestone for flux comes along the Berry canal from La Moriente. The coal is railed from Le Creusot to Decize and travels thence by canal to Nevers. Some comes by the Canal du Centre and the canalized Loire from Montceau-les-Mines. The Berry canal, with its three branches, is about 160 miles long. It joins the Loire navigation at Marseille-les-Aubigny to that of the Cher by way of Bourges. Its navigable depth is only about four feet, and it can only carry barges loaded to 65 tons, of the type known as '*Berrichon*'. The most important branch is the one that serves Montluçon, carrying iron and pig from Lorraine. Draught is by horse, donkey or mule. The freight carried amounted in 1936 to about 270,000 tons.

The middle Loire is provided with a lateral canal which runs for 120 miles from Briare to the neighbourhood of Digoin. It joins the Berry canal at Marseille-les-Aubigny. The port of Orléans can only be reached by vessels drawing about three feet, but the section between Combleux and Montargis is being deepened. From Digoin a canal of regulation dimensions passes to Roanne, carrying coal and pig-iron among other articles.

The *Canal du Centre* joins Digoin on the Loire at 740 feet above sea-level, with the Saône at Châlon at 570 feet. It has a depth of six feet. This canal follows the Carboniferous synclinal depression,¹ utilizing the valleys of the Dheûne and Bourbince. Its water is supplied in part by the Arroux, which joins the canal and the Loire at Digoin. It serves the Le Creusot coal-mining

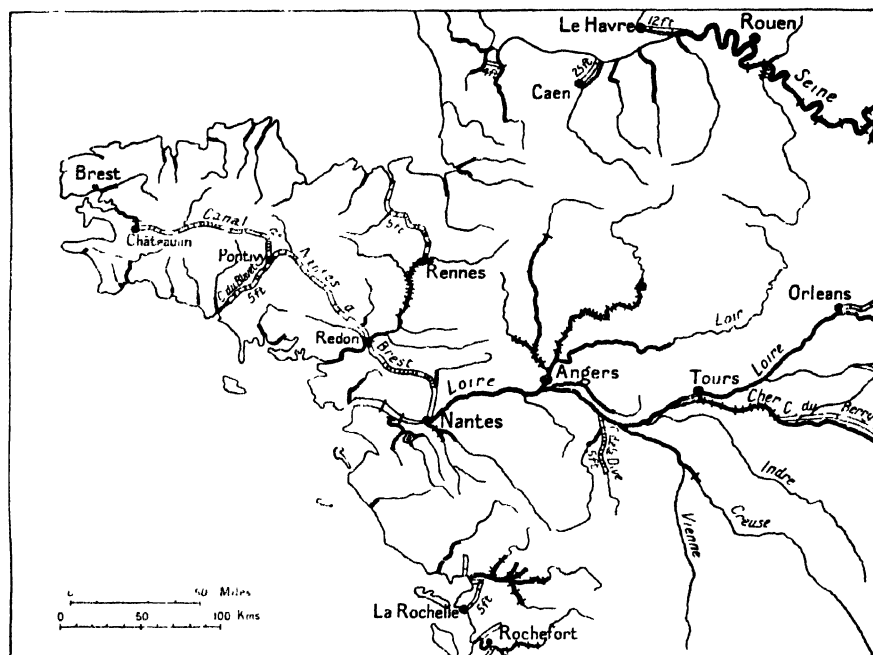


FIG. 100. THE NAVIGABLE WATERWAYS OF THE LOWER LOIRE AND BRITTANY.

area, and the mines of Perrecy, Blanzey-sur-Bourbince, Bois-Bretoux and Perreuil have wharves along its banks. At Bois-Bretoux the Le Creusot railway has sidings on the canal.

The *Lower Loire* is rarely navigable above Tours and has no lateral canal. It is connected at Nantes with the Breton waterways, which distribute about half a million tons of goods per annum, chiefly coal and coke and agricultural machinery by the Nantes-Brest canal. Nantes receives a certain amount of traffic, about 100,000 tons, from upstream. This includes iron-ore from the *bocage*, timber and agricultural produce. The upstream movement is slightly larger and concerns seaborne coal, manufactured iron and steel goods, and fertilizers. There is very little traffic above Angers.

¹ p. 44.

Much has been said and written of late years about the possibilities of the Loire as a great national highway, and a post-1918 experiment, aiming at the control of a section of this unruly and capricious river, was made by the State during the 'twenties. By a system of groins, scientifically arranged with regard to the shape of the channel and the set of the current, it has been sought

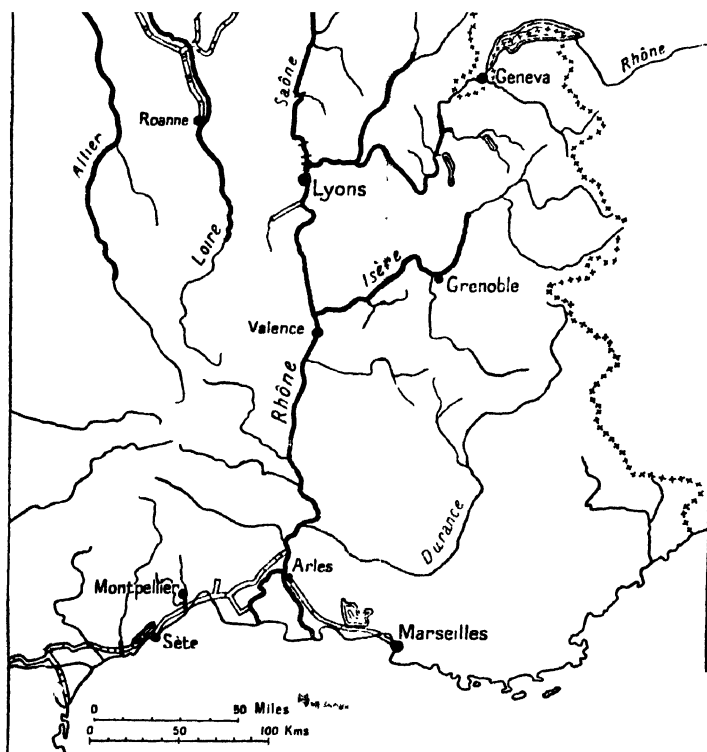


FIG. 101. THE SAÔNE-RHÔNE WATERWAY AND THE CANALS OF PROVENCE AND LANGUEDOC.

to stabilize the shifting bed of the river and to provide a deeper channel at mean and low water. The results have not so far proved satisfactory, and the traffic, even in the 'improved' section, remains insignificant.

Inland navigation in Provence and Languedoc is on a very small scale at present. We have seen the obstacles presented by the steep gradient and irregular régime of the Rhône. The traffic of Lyons does not exceed 1,000,000 tons, including quays along the Saône and those along the Rhône below the town, although the

Rhône is well served with canal connexions. The Canal du Centre, the Loire lateral canal and the Burgundy canal connect it with Paris. The Rhine-Rhône and the Marne-Saône canals form connecting links with eastern France and Central Europe. Between Pont-St.-Esprit and Arles on the lower Rhône a regular service of tugs is provided. The barges are of the heavy *chaland* type, capable of carrying 500 tons, but drawing only five feet. These heavy boats sometimes go right through by sea to Marseilles and Sète (Cette), and sea-boats also navigate the river up to and sometimes beyond Arles. From Beaucaire a canal leads from the Rhône to Sète. It is supplied by the river Vidourle, which drains the edge of the Cévennes between Hérault and Gard. The canal crosses the drained Bellegarde marshes and reaches the Mediterranean coast at Aigues-Mortes, when it follows the coastal lagoons to the Etang de Thau. There is a depth of six and a half feet. Wine is the most important cargo carried upstream towards Beaucaire, probably largely from North Africa, but Languedoc wine is also sent down the canal to Sète for export. Wine-casks travel downstream from Beaucaire. Apart from this the downstream traffic is very slight. There is a small traffic in bauxite to Sète.

From Arles a canal, which was intended, as first projected, to link the Rhône with Marseilles, reaches the coast at Bouc. It is only six feet deep and will eventually be replaced by a canal of the dimensions of the new ship canal that joins Bouc with Martigues and the Rove tunnel to Marseilles, along the southern edge of the Etang de Berre. Unless and until the Arles-Bouc canal is enlarged and the Rhône canalized, there will not be any great development of traffic between Marseilles and the Rhône, though the small Mediterranean ports, as well as Marseilles, will benefit from the improved communications offered by the Rove Tunnel and the Martigues-Port de Bouc navigation ; for the main distributary of the Rhône from Arles to the sea at St. Louis is very badly hindered by silting, which, after heavy floods, wedges the lock gates.

The *Canal du Midi* connects Toulouse with the Etang de Thau and Sète. It has a depth of only five and a half feet, can only carry 120-ton boats, and is not much patronized. Its main function is to carry coal, wine, and mineral oil and casks, totalling 502,000 tons in 1936. Wine moves in both directions from the Bordeaux and Languedoc districts, and is imported at Sète from Algeria.

The traffic on the Garonne tributaries is almost negligible, although the Garonne lateral canal has slightly greater capacity than the Canal du Midi and can take 180-ton boats. The Lot

and the Tarn are no longer officially classified as navigable rivers. The Dordogne is navigable from its junction with the Garonne at Libourne, a distance of twenty-five miles. Between Bergerac and Génissac there is only a depth of a little over three feet, and this section carries no traffic to speak of. Wine and casks are the chief commodities carried below Libourne.

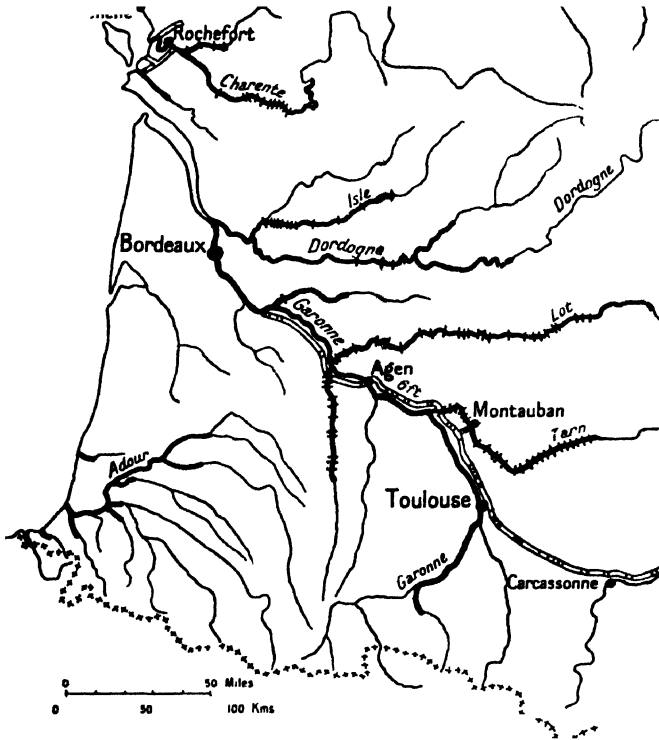


FIG. 102. THE NAVIGABLE WATERWAYS OF THE SOUTH-WEST. THEY CARRY VERY LITTLE TRAFFIC.

Since the war of 1914-18 considerable progress has been made in rendering more efficient the navigable rivers and the canals. On the former, dredging and embanking have improved channels and on the latter obsolete locks and bridges have been replaced by modern constructions and in some instances provision has been made for two way traffic. The electric tractor has largely replaced horse towage and self-propelled barges are increasingly used. Between 1920 and 1936 the total freight carried by mechanically-propelled barges rose from 1.2 per cent to 26.4 per cent of the total tonnage conveyed.

The magnificent road system of France, with its national, departmental and minor ramifications, penetrating into every corner of the country, is rapidly extending its influence as a unifying factor in the land. But space has not permitted us to deal in detail with more than one of the great French systems of communication.

The waterways have been selected for a special study because, to a much greater extent than roads and railways, their development and utilization is dependent upon geographical conditions. It is not the function of the geographer to decide as to the economic justification for their development and maintenance. For him they exist as a geographical fact, and he is concerned to show the part they play in the relation of man to his environment.

In the descriptive analysis attempted in this chapter, in map and text, two facts become clear. First, the canals have been the means of intensifying the natural features of concentration on the Paris basin, provided by the rivers; and, second, their modern utilization and development is dependent, in the main, on the industrial groupings necessitating transport of bulk cargoes; this grouping in turn is related to the scattered coal-fields. What is not so evident, but is, nevertheless, important, is the part played by the canals in moving small cargoes for the peasant farmer, who is enabled by them to transport earth, lime, manure, fertilizer, farm produce and so forth, at a minimum cost. It remains to be seen whether with motor transport development, the road will not prove to be a better friend to him than the canal.

INDEX

N.B.—Figures in heavier type denote pages on which special reference is made to the subject.

Figures in italics denote pages on which maps dealing with the subject are to be found.

R= River. C= Canal.

- Aa, R., 177-81, 475-6
- Abbeville, 170
- Absinthe, 273
- Adour, R., 204, 216, 227
- Afforestation, 50, 121, 159, 238-9, 304, 378, 396
- Agly, R., 209
- Agriculture, 81, 86, 96, 144, 150, 155, 161, 193, 221, 231, 234, 236, 276, 293, 294, 331, 352, 353, 369, 376, 398-424, 512, 514
- Ahun, coal-field of, 57, 58, 61
- Ain, R., 276-8
- Aire C., 472-3
- Aire, R., 128-9, 333
- Aire-sur-la-Lys, 186
- Aisne-Oise C., 478
- Aisne, R., 130-1, 479-80
- Aix-en-Provence, 315
- Ajaccio, 321
- Albères, 206-7
- Albi, 72, 436
- Alès, 302
 - coal-field of, 436
- Alimentary industries, 141, 159, 241, 273, 386, 394
- Alise Ste. Reine, 110-11
- Allier, R., 45-55
- Almonds, 63, 70, 301, 398
- Alps, French, 244-60
- Alsace, 323, 325, 365-80, 373, 375
- Aluminium, 250, 252, 255, 441, 447-8,
 - See also* Bauxite
- Amiens, 168-70
- Ancenis, 100-1
- Andorra, 209-11
- Angers, 100
- Angoulême, 240-1
- Anjou, 99-101
- Annecy, lake of, 252
- Anthracite, 195, 319
- Antibes, 317-18
- Aquitaine, basin of, 220-48
- Aran, Val d', 219
- Arc, R., 254-6
- Arcachon, 237-8
- Arcoët, 82-8
- Ardèche, R., 300
- Argile plastique*, 126, 130, 132
- Argiles vertes*, 126
- Argonne, 129-30
- Ariège, R., 209-12
- Arles, 305, 417
- Arles-Bouc C., 494
- Armaments, 164, 436
- Armançon, R., 110-11
- Armentières, 198
- Armor, 84-94
- Armorican Massif, 75-101
- Arras, 191
- Artois, 4, 166, 171, 174
- Arve, R., 249-51
- Aspe, Val d', 219
- Aubusson, 58
- Auge, Pays de, 149
- Aurillac, basin of, 68
- Authie, R., 171
- Autun, 45
- Autun-Epinac coal field, 45
- Auvergne, 45-55
- Auxerre, 115
- Avelon, R., 133
- Avens*, 64, 68
- Avignon, 301-2
- Ax-les-Thermes, 209, 210
- Balon d'Alsace, 265, 335
 - Banyuls-sur-Mer, 207
 - Barley, 412, 413
 - Barrois, Le, 114
 - Basalt, 48, 51, 67
 - Bas Languedoc, 297, 306-8
 - Basque Pays, 226
 - Bassigny, 113, 361
 - Bastia, 321, 322
 - Bastide, La, 72
 - Baussac, 68
 - Bauxite, 304, 307, 314, 316-17, 449
 - Bayeux, 153
 - Bayonne, 227
 - Beauce, 124
 - Beauvais, 133
 - Bedous, 222
 - Beer, 123, 141, 273
 - brewing, 323
 - Belfort, 266-7

- Bergues, 182
 Berry C., 56, 491
 Besançon, 274-5,
 Bessin, 143
 Béthune, 181, 190
 Bienne, R., 276
 Blache, V. de la, 171, 333
 Blois, 155, 159, 160
 Bocage, 78, 82, 90, 172, 241, 399-401,
 408
 Bocage of Anjou and Vendée, 99-101
 of les Veys, 95
 of Maine (Manceau), 97-9
 of Normandy, 94-7
 Bonifacio, 321
 Bordeaux, 234-7, 258, 335
 wine, 235-6, 421
 Boulogne, 178
 Boulonnais, 171-4
 Bourbon basin, 54
 Bourbonnais, 437
 Bourbourg C., 475
 Bourges, 157-8
 Brandy, 234-6
 Brassac, 49, 436
 Bray, 133-4
 Brenne, Pays de, 160-1
 Bresse, 92
 Bresse, basin of, 263-4
 Brest, 79, 91-92, 342
 Briançon, 258
 Briançonnais, 246, 254, 258, 259
 Briare C., 117, 491
 Brie, 124-8
 Briey, 349
 Brignoles, 316
 Brioude, 47
 Brissac-les-Mines, 47
 Brittany, 78-101
 Brive, basin of, 61-2
 Buckwheat, 59, 408, 412-13, 414
 Building materials, 49, 114, 116, 133,
 141, 173, 342, 354, 362
 Burgundy C., 491
 Burgundy, Gate of, 265-7
 plain of, 268
 wine, 268, 421
 Caen, 150, 151, 444
 Campagne de, 149-50
 Cahors, 65
 Calais, 185-6
 Calcaires grossières, 411
 Calvi, 321
 Camargue, 305-6
 Cambrai, 192
 Canals, 466-95
 Aire, 472-3
 Aisne-Oise, 478
 Arles-Bouc, 494
 Berry, 56, 491
 Bourbourg, 475
 Briare, 117, 491
 Burgundy, 491
 Centre, 44, 491
 Deule, 472-4
 Est, 339, 360, 363, 487-8
 Furnes, 474
 Loire Lateral, 55, 491-2
 Marne Lateral, 480
 Marne-Rhine, 355, 486-8
 Marne-Saône, 490
 Midi, 303, 312, 494
 Nivernais, 491
 Oise Lateral, 478-9
 Ourcq, 482
 Rhine-Rhône, 274, 485
 St. Quentin, 474
 Sambre-Oise, 478
 Sarre Colliery, 490
 Sensée, 474
 Somme, 476
 Cancale, Bay of, 85, 88
 Canche, R., 171
 Cannes, 317
 Cantal, 47-49
 Capcir, 207
 Carlitte, 207
 Carcassonne, 206, 232, 233
 Carmaux, coal-field of, 436
 Castres, 72
 Cattle, 47, 50, 54, 59, 60, 83, 115, 251,
 255, 352, 384, 399, 401, 408-8,
 404, 407
 Causses, 30, 399-401
 Cantal, 66
 Grammat, 62
 Larzac, 70, 71
 Limogne, 62
 Martel, 62-3
 Méjean, 70
 Mende, 68
 Quercy, 62, 65
 Rodez, 66
 Sauveterre, 68
 Sévérac, 67-8
 Cauterets, 218
 Caux, 142-5
 Cellulose, 306
 Cement, 173, 221, 256, 293, 313, 362,
 449
 Central Massif, 27-73
 Centre C., 44, 491
 Centre, Le, 55
 Cerdagne, 207
 Cette. *See* Sète
 Chablais, 249
 Chagny, 269
 Chalk, 116-19, 174, 176
 Chalon-sur-Saône, 263, 268
 Châlons-sur-Marne, 122-3
 Chambéry, 252, 254
 Chambon, 56
 Chamonix, 249

- Champagne Berrichonne, 156-7
 humide, 115, 116
 pouilleuse, 119-23
 Charente, R., 240-8
 Charleville-Mézières, 362
 Charmes, 339
 Chartres, 137, 139
 Cheese, 49, 54, 60, 68, 71, 126, 134,
 157, 251, 253, 255, 258, 272, 273,
 395, 401, 403, 406-7
 Chemicals, 52, 53, 56, 112, 141, 195,
 250, 288, 293, 313, 352, 371, 398,
 429, 430, 449-51, 478, 479, 485
 Cher, R., 55-7
 Cherbourg, 97
 Chiers, R., 361-2
 China. *See* Pottery
 Cider, 118, 153, 398, 418
 Clairvaux, 114
 Clermont-Ferrand, 51-2
 Climate, 7-23, 205
 Central Massif, 34, 48, 53
 continental, 19, 20
 maritime, 15-19, 416
 Mediterranean, 21, 23, 259, 294
 Coal, 42, 56, 57, 61, 67, 133, 194-6,
 197, 264, 290, 307, 319, 338, 355-8,
 425-7, 431-7, 475, 482
 imports, 147-8, 173, 235, 237, 241,
 312, 428
 movement of, 55, 344-5, 371, 376,
 386-7
 Coal-fields:
 Le Creusot-Blanzy, 45, 427, 485-6.
 Loire, 42, 485
 Nord and Pas-de-Calais, 194-6, 433-5
 Sarre, 355-7, 433
 Coke, 42, 195, 196, 197, 387, 435, 445,
 483
 Colmar, 371
 Commentry, 56
 Communications, 457-94, 512-13
 Compiègne, 133
 Copper, 141, 159, 236
 Corallian limestone, 114
 Cork industry, 313, 315
 trade, 236
 Corsica, 318-22
 Cotentin, 94-6
 Côte d'Or, 268
 Côtes, Les, 332
 Cottage industry, 50, 121, 145, 264,
 278, 354, 379, 429
 Cotton imports, 148, 388, 429
 industry, 44, 121, 145, 147, 167, 170,
 198, 336, 370, 371, 429, 430, 452-4
 Craponne, 39
 Crau, 303-4
 Creil, 133
 Creuse, R., 57-9
 Cultures *maratchères*. *See* Market Gar-
 dening
 Cyclones, 9-11
 Dairy farming, 96, 193, 243, 276, 279,
 331, 393, 394, 405-8
 Decazeville, 236, 436
 Deforestation, 299, 396
 Denain, 444
 Depopulation, 54, 65, 67, 99, 241
 Deule C., 472-4
 Dieppe, 464
 Dijon, 268-9
 Dombes, 280, 413
 Donnezan, 207
 Donzère, 296
 Dordogne basin, 289-40
 Dordogne, R., 63-4
 Douai, 192, 196
 Doubs, R., 270-6
 Drac, R., 257
 Drainage canals, 175
 Drôme, R., 259-60
 Dunes, 175-6, 231, 237-8, 397
 Dunkirk, 182-5, 474
 Durance, R., 258
 Dyeing, 121, 147, 293, 371, 378, 430
 Electricity, 437-40
 hydro-, 50, 63, 210, 211, 212, 215,
 216, 218, 222-5, 250, 254, 255,
 256, 257, 258, 259, 278-9, 284-5,
 426
 thermal, 386, 426, 435
 Engineering, 448-9
 Epervay, 126
 Epinal, 386, 337, 338
 Escaut, R., 192-8
 Espalion, 67
 Est C., 339, 360, 363, 487-8
 Esterel, 314, 317
 Eure, R., 148
 Evieux, 56
 Exports, 506-7. *See also* individual
 ports
 Figs, 53, 65
 Fins, 54
 Fisheries, 87-89, 96, 144, 173, 238-9,
 243, 280, 315
 Flanders, French, 174-98
 Flax, 51, 196, 430, 452
 Flour milling, 68, 159, 267, 312, 381
 Fodder crops, 413-14
 Foix, 212
 Forests, 396-8
 Forez, 39-41, 53
 Franche Comté, 272
 Fréjus, 316-17
 Frontiers, 4, 5, 194, 196, 212-13,
 245-6, 252, 266, 270, 277, 342,
 349, 351, 354, 356, 363, 369, 376
 Fruit, 398-9. *See also* Market Gar-
 dening

- Fruitières*, 253, 255, 273
 Furniture-making, 47, 116, 264, 274,
 277-8, 293, 345, 397
 Furnes C., 474
- Gaize, 129-30
 Gap, 258
 Garonne, R., 212-17, 231-9
Garrigues, 299, 300, 306, 314, 319
 Gâtinais, 117
 Gault Clay, 115-16, 155-6, 257
Gaves, 203-4
 Geese, 60, 64, 234, 239
 Gennevilliers, 142
 Gex, 277
 Gironde, R., 237
 Givors, 290
 Glass, 133, 141, 290, 336, 338, 345, 357
 Glove-making, 68, 70-1, 219, 256, 401
 Goats, 157, 330, 396, 404
 Grammat, Causse de, 62
 Granite, 82, 96-7, 101
 Granville, 95-6
 Grasse, 317
 Gravelines, 181
 Gray, 267
 Grenoble, 256-7
 Grésivaudan, 255
 Groix, 88
 Gueret, 58
- Hat manufacture, 292-3, 339, 345, 354,
 412
 Hemp, 51
 Hérault, 308
 Hercynian folds, 27, 39, 44, 56, 99,
 161, 194, 261, 270, 290
 Hops, 374, 376
 Horses, 60, 150, 173, 279, 306, 376,
 405
 Hosiery, 52, 54, 118, 121, 275, 293,
 371, 378
 Hydro-electricity. *See* Electricity
- Ill, R., 366-74
 Imports, 506-7. *See also* individual ports
 Industry, 425-56, 511-15. *See also*
 individual industries
 factors in localization of, 425
 Industrial regions:
 Centre, 39, 42, 55, 445-6
 East, 427. *See also under* Lorraine
 Lower Loire, 429. *See also* Nantes
 Lyons, 527
 North, 426-7
 Paris, 428-9
 Inland navigation, 466-94. *See also*
 Canals and individual rivers and
 canals
 Iron and steel industry, 72, 96, 100,
 109, 116, 133, 141, 157-9, 162-4,
 274-5, 290-307, 425, 440-6
- Lorraine, 343, 344, 346, 348, 349-52,
 357-9, 362-3, 441-4
 Normandy, 152-5
 North-east France, 173, 187, 193,
 196, 197
 Pyrenees, 210-11, 214
 Iron and Steel, traffic in, 152, 235, 244
 Iron-ore, 71, 96, 114, 162, 164, 173, 193,
 196, 236, 274, 279, 307, 376, 440-6
 Lorraine, 340-4, 386, 387, 425, 441-4
 Normandy, 96, 151
 Pyrenees, 210-11, 214
 Iron-ore, traffic in, 164, 173, 196, 345,
 359, 376, 386, 387
 Iron, pig, 152, 343, 345, 359, 363
 Irrigation, 51, 59, 64, 72, 206, 216, 218,
 231, 234, 240, 255, 258, 294, 299,
 300, 302, 304, 306, 308, 311, 316,
 371, 374, 405, 415
 Isbergues, 196
 Isère, R., 252-7
 Isigny, 153
- Joef, 349, 350
 Jura, 269-80
 Jurassic limestone, 242, 246, 261, 271
- Kaolin, 61, 96
 Karst, 67-8, 271, 273, 276, 285, 319
 Kembs, 437-9, 485-6, 489
 Keuper marl, 331, 352
 Kimmeridge clay, 114-15
- Lace-making, 38, 39, 50, 153, 193,
 264, 336, 429
 Land-building and reclamation, 86,
 87, 92, 303, 315, 368
Landes, Les, 237-9
 Langeac, 46
 Langres, 109, 110, 267
 plateau of, 109, 109-10
 Lannion, 87
 La Pallice, 243
 La Rochelle, 243
 Laruns, 221
 Larzac, Causse de, 70, 71
 Lauragais, gap of, 232, 233
 Laval, 99
 Leather, 52, 68, 70-1, 115, 141, 161,
 219, 241, 256, 257, 288, 289, 312,
 323, 345, 372
 Leather, traffic in, 173, 232, 236, 312
 Le Creusot, 44
 Le Creusot-Blanzy coal-field, 45, 427,
 435-6
 Le Havre, 148
 Lens, 195-6
 Le Touquet, 170-1
 Lhers, R., 212
 Lias clays, 57, 63, 67, 68, 113, 160, 248,
 270, 331
 Lignite, 307-8, 312, 387, 438

- Lille, 190, 196
 Limagne, 49-51
 Bourbonnaise, 53
 Limestone. *See* Jurassic, Shelly
 Limoges, 60-61
 Limogne, Causse de, 62
 Limon, 125, 168, 177, 231, 300
 Linen, 145, 430
 Linguistic frontier, 354, 378
 Livradois, 49-50
 Loess, 85, 167
 Loing, R., 117
 Loire Lateral C., 55, 491-2
 Loire, R.:
 lower, 161-4, 429, 492, 493
 middle, 154-61
 régime of, 158-9
 upper, 36-55
 Longwy, 350-2
 Lons le Saunier, 277
 Lorient, 92
 Lorraine, 323 et seq
 boundaries of, 325
 iron-field of, 340-4, 386, 387, 425.
 411-14
 Lot, R., 65-9
 Lourdes, 217, 219
 Lozère, 68, 69
 Luc, le, 316
 Lunéville, 339
 Luz, 218
 Lyons, 278, 286-9, 427, 446, 493
 Lys, R., 186-90

 Machinery, 121, 142, 159, 161, 193,
 196, 257, 274, 293, 338, 436
 Maerl, 85
 Maine, R., 97-9
 Maize, 418
 Manceau, Bocage, 97-9
 Maquis, 314-15, 317, 319
 Marble, 214, 217
 Marennas, 242
 Market Gardening, 86, 150, 153, 160,
 168, 180, 294, 300, 302, 314,
 316-17, 318, 339, 395, 415-18
 See also primeurs
 produce, traffic in, 235
 Marne, R., 109-10, 480
 Marne Lateral C., 480
 Marne-Rhine C., 355, 486-8
 Marne-Saône C., 490
 Marquaireries, 379
 Marseilles, 308-18, 494
 trade of, 312, 313
 Martel, 63
 Martonne, E. de, 75
 Maubeuge, 193, 194
 Maures, 314-15
 Mayenne, R., 98-9
 Mazamet, 72, 236, 436
 Meat, 401-8

 Méjean, Causse de, 70
 Melun, 126
 Mende, 68
 Mende, Causse de, 68
 Metallurgical industry, 196, 436. *See*
 also Iron and Steel Industry
 Metz, 346-7, 348
 Meulnières, 125, 128
 Meurthe, R., 337-40
 Meuse, Côtes de, 334
 Meuse, R., 333-4, 359-64
 Mezières, 362
 Midi C., 303, 312, 394
 Milk. *See* Dairy Farming
 Millau, 70-1
 Millevaches, plateau of, 57-60, 365
 Mineral oils, 147-8, 376
 Mineral waters, 52, 53, 56, 218-19, 239,
 251, 254, 276, 335
 Mistral, 294-9, 311, 317-18, 416
 Monaco, 318
 Montargis, 117
 Montauban, 232
 Montagne Noire, 71-3
 Montbéliard, 274
 Mont Blanc, 249-50
 Montbrison, 39, 40, 41
 Montceau-les-Mines, 44-5
 Mont Dol, 86-7
 Montélimar, 295
 gate of, 294-5
 plain of, 295
 Montgaillard, 212
 Montluçon, 53, 56
 Montpellier, 307-8
 Montreuil-sur-Mer, 171
 Morlaix, 87
 Morvan, 111, 112
 Moselle, Côtes de, 332, 340
 Moselle, R., 334, 335-41, 489-90
 Motor industry, 56, 141-2, 273-5, 286,
 428
 Moulins, 54
 Moutiers, 254
 Mulberry, 63, 255, 293-4, 299, 310
 Mulhouse, 370-1
 Muschelkalk. *See* Shelly limestone

 Nancy, 344, 344-5, 442
 Nantes, 161, 162-4, 429, 492
 Neubourg, Campagne de, 148
 Neufchâteau, 361
 Nevers, 55
 Newfoundland fisheries, 87
 Nice, 318
 Nîmes, 306-7
 Nitrates, 218
 Nivernais, 55
 Nivernais, Bas, 156
 Nivernais C., 491
 Normandy, 148-53
 iron-field of, 151-2

- Oats, 411, 412
 Oil. *See* Mineral oils
 Oise Lateral C., 478-9
 Oise, R., 128-34, 477-9
 Oléron, Isle of, 242
 Olive oil, 303, 398
 trade in, 236, 312, 318, 428
 Olives, 206, 299, 301, 302, 310, 316, 398, 412, 420, 421
 Oloron, 221-3
 Oolite plateaux, 108-13, 352
 Orchards. *See* Fruit, Market Gardening
 Orléans, 159
 Orléans, Forêt d', 117
 Orne, R., 149-50
 Ossau, Val d', 219
 Othe, Forêt d', 118
 Ourcq C., 482
 Oxford clay, 113-14, 149, 271, 332, 345
 Oysters, 88, 96, 238, 242

 Pagny, 361
 Paimbœuf, 164
 Pallice, La, 243
 Paluds, 301
 Paper mills, 141, 143, 145, 147, 215, 240, 256, 260, 336, 379, 397
 Paris, 184-41, 136, 143, 482-3, 466
 Basin, 108-64, 427, 428
 Pastoral Industry, 48, 58, 222, 233, 253, 272, 388
 Pastures, 399-400
 Pau, 217
 Gave de, 217-24
 Pechelbronn, 376
 Pelvoux, 258
 Perche, Colline du, 149
 Perfumes, 417
 Périgord, 229, 405
 Périgueux, 240
 Péronne, 168
 Perpignan, 206-7
 Perthois, 116
 Petite Rosselle, 357
 Petroleum. *See* Mineral Oils
 Pfalsbourg, 377
 Phosphates, 450
 Phylloxera, 234, 241, 242, 403, 408, 423
 Picardy, 166-71
 Pierrelatte, basin of, 300-1
 Pigs, 153, 243, 394, 404
 Pine (*Landes*), 238-9
 Pit-props. *See* Timber
 Plages, 90, 144, 170, 227
 Planèze, 48
 Plomb du Cantal, 48
 Poitou, 231, 403, 408
 Polders, 175-6
 Pont-à-Mousson, 346, 355, 442
 Pontarlier, 273
 Pontivy, 83
 Population, 83, 372, 377, 378, 393, 502-4
 distribution of, 35, 373
 foreign, 196, 198, 313
 Porto-Vecchio, 321
 Potash, 365, 371, 388, 394, 449-50
 Pottery, 61, 141, 153, 157, 158, 173, 302, 339
 Poultry, 280, 394
 Preserving industry, 51, 52, 64, 141, 162, 303, 347, 374, 386, 417
 Primeurs, 82, 87, 92, 96-7, 206, 302, 314, 316-18, 395, 398, 415-18, 420, 421. *See also* Market Gardening
 traffic in, 173, 206, 303
 Provence, 299-303
 eastern, 308-18
 Proviens, 126
 Puy de Dôme, 38
 Puy, le, 31, 36-39
 Pyrenees, 200-27

 Quarries, 221, 241, 362, 372
 Quercy, Causses de, 62, 65

 Railways, 457-65
 electric, 218, 222, 227, 276, 349, 457
 Rayon, 121, 275, 293, 371, 378, 455-6
 Reims, 131-2
 Forêt de, 128
 Remiremont, 335-6
 Rennes, 93-4
 basin of, 83, 93
 Resin, 235, 237-9, 397
 Rhine, R., 367-89
 régime of, 381-4
 Rift Valley, 262, 365-6
 Rhine-Rhône C., 274, 485
 Rhône, R., 251-2, 261-2, 280-96, 299-303
 navigation, 283-6
 plains, 289-90
 régime of, 280-3
 Rias, 84-6
 Rieds, 366-7
 Rivers. *See* individual rivers
 Riviera, 317-18
 Roads, 6, 494
 Roman, 122, 162, 168, 305, 310, 337
 Roannais, 42-4
 Roanne, 42, 44-5
 Rochefort, 242
 Rochelle, La, 242, 243
 Rodez, 67
 Rodez, Causse de, 66
 Ronchamps, 264
 Roquefort, 71
 Roscoff, 87, 92
 Roubaix, 198

- Rouen, 145-7, 430, 453, 484
 Rouergue, plateau of, 65
 Roussillon, 205-9
 Roye, 166
 Rubber, 52, 56, 141, 173
 Rye, 56, 59-60, 82, 222, 408, 411-12, 413

 Saarbrücken, 355
 St. Claude, 277
 St. Denis, 139, 141, 142
 St. Dié, 837, 838, 378
 St. Dizier, 116
 St. Etienne, 38, 41-2, 190, 236, 435, 445
 St. Genix, 67
 St. Jean d'Angély, 241
 St. Malo, 85, 87
 St. Nazaire, 162-4
 St. Omer, 178-80
 St. Quentin, 167
 St. Quentin C., 474
 St. Valéry, 170
 St. Venant, 188
 Salat, R., 215
 Salon de Province, 303, 304
 Salt, 277, 306, 352, 354
 Sambre, R., 193
 Sambre-Oise C., 478
 Santerre, La, 166-7
 Saône, R., 261-9
 Sardine fisheries, 88-9, 162, 238
 Sarre Basin, 353-9
 Sarrebourg, 353, 354
 Sarre coal-field, 355-7, 431, 441, 443
 River, 353-5
 Territory, 355-6
 Sarre Colliery C., 490
 Sarreguemines, 354
 Saverne, 377
 Saulieu, 112
 Saulnois, 352-8
 Saumur, 161, 421
 Sauveterre, Causse de, 68
 Scarpe, R., 191-2
 Scheldt. *See* Escaut
 Seaweed, 85-6, 89, 95
 Sedan, 362
 Ségalas, 30
 Seine, R., 106-13, 476-85
 Sélestat, 368, 374
 Sensée C., 474
 Sète, 807-8
 Séverac, Causse de, 67-8
 Sheep, 400-3. *See also* Transhumance
 Shelly limestone, 330
 Shipbuilding, 91-2, 145, 162-3, 242, 429-30, 448
 Silk, 38, 121, 250, 252, 254-7, 278, 281, 288, 290, 292-3, 371, 378, 427, 455
 Silver, 218, 379

 Sisteron, 259
 Slates, 81-4, 100-1, 214, 363
 S.N.C.F., 457-8
 Soap, 141-2, 162, 304, 312-13, 398
 Soda, 354, 388
 Sologne, 159-60
 Bourbonnaise, 55
 Somme C., 476
 Somme, R., 166-71
 Sotches, 64, 71
 Souterraine, La, 58
 Steel. *See* Iron and Steel
 Strasbourg, 373, 384-8
 Sugar beet, 51, 60, 114, 118, 126, 150, 156, 167, 239, 242, 302, 331, 400, 410-11, 414-15
 refineries, 142, 167, 312-13, 323, 415
 Superphosphates, 164, 236, 242, 394, 450

 Tancarville, 147, 485
 Tanning. *See* Leather
 Tarare, 44
 Tarascon, 211
 Tarbes, 217, 219
 Tardenois, 126-8
 Tardets, basin of, 224
 Tarn, R., 69-70
 Tectonic basins, 30-1, 35, 37, 39, 42, 47, 49-50, 106, 207, 262, 270, 289, 300, 337
 Tertiary deposits, 85, 158, 160, 174, 231, 262, 268
 Massif, 123-4
 Textiles, 38, 44, 52, 68, 121, 145, 150, 167, 170, 194, 196-8, 212, 236, 264, 267, 274, 275, 278, 293, 307, 323, 336, 337, 338, 339, 345, 370, 371, 372, 378, 379, 426, 427, 428, 430, 451-6
 trade in, 236, 288, 312
 Thiérache, 193
 Thiers, 51
 Thionville, 347-8, 441
 Timber, 53, 112, 114, 274, 277, 278, 338, 397
 barrel staves, 64, 70, 307, 345, 379
 pit-props, 164, 173, 235, 238-9, 262, 297, 362
 planks, 160
 traffic in, 148, 155, 164, 170, 173, 233, 236, 237, 284, 312, 345, 362, 378, 379
 Tobacco, 64, 209, 233-4, 239, 323, 374, 376
 Tonnay, 241-2
 Tonnerois, Le, 114
 Toul, 345
 Gap, 845-6
 Toulon, 814
 Toulouse, 232-4

- Touraine, 160-1
 Tourcoing, 198
 Tours, 161
 Transhumance, 48-9, 54, 69, 214, 251, 253, 255, 258, 304, 379, 395, 399, 402-3, 406-7, 464
 Transport. *See* Canals, Communications, Railways
 Troyes, 120-1
 Truffles, 64, 240, 247
 Tulle, 62
 Turkeys, 234, 239
 Turves, 316
 Urugne, R., 68
 Valence, 298
 plain of, 292-4
 Valenciennes, 193
 Valois, 128
 Vannes aqueduct, 118
 Velay, 38
 Vendée, Bocage of, 99-101
 Vendean Massif, 101
 Verdun, 363
 Veys, Bocage of les, 95
 Vichy, 52-3
 Vienne, 161, 291-2
 plain of, 290-2
 Vienne, R., 59-62
 Vine, 51, 57, 63, 64, 68, 70, 72, 101, 122, 131, 156, 157, 158, 159, 161, 206, 207, 214, 224, 225, 234, 237, 239, 240, 241, 254, 258, 268, 276, 277, 292, 293, 301, 302, 306, 308, 316, 346, 352, 367, 372, 374, 398, 417, 418-24
 See also Wine
 Vitry-le-François, 115, 116
 Vosges, 329-80, 335, 365, 377-80
 Walnut, 257-8, 301
 Watch-making, 250, 264, 274-5, 278
 Water-power, 46, 51, 61-2, 116, 130, 145, 168, 272, 274, 278-9, 336, 427, 429, 436. *See also* Electricity
 Water-supply, 118-19, 168, 171, 170, 250, 302, 349, 370-1, 410, 425
 Waterways, inland, 486-95
 Wheat, 408-11
 Wine, 118, 122, 123, 126, 131, 147, 161, 233, 236, 237, 269, 277, 307, 347, 372, 418-24
 blending, 236
 Bordeaux, 235, 236, 421
 Burgundy, 268, 421
 Champagne, 122-3, 421, 423
 traffic in, 147, 150, 155, 157, 162, 164, 173, 233, 235, 236, 269, 312, 421, 422, 423, 424
 Wool, 401-3, 429. *See also* Textiles
 traffic in, 145, 150, 162, 236
 Woollen industry, 44, 51, 58, 68, 72, 109, 121, 122, 131, 145, 159, 160, 196, 197, 217, 218, 222, 224, 292, 362, 378, 403, 429, 451-2
 World War (of 1914-18), 135, 167-8, 236, 330, 337, 347, 354, 363-4, 370, 386, 394, 397, 415; (of 1939-44), 425, 430-1, 434, 511-13
 Yonne, R., 112, 481-91
 Ypres, plateau of, 188
 Zorn, R., 377